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May 15, 1961

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NUCLEAR SCIENCE ABSTRACTS

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GENERAL AND MISCELLANEOUS

10592 (ARL-TN-60-141) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE FLUID DYNAMICS OF ROCKET COMBUSTION. Loren E. Bollinger, Michael C. Fong, Donald R. Halagan, and Rudolph Edse (Ohio State Univ., Columbus. Rocket Research Lab.). Nov. 1960. 29p. Contract AF33(616)-5615, Project No. 7013, Task No. 70179.

The effect of transverse magnetic fields on the formation of detonation waves was studied with hydrogen-oxygen mixtures in a 50-mm diameter cylindrical tube. Both steady-state and oscillating (60 cycles/sec) fields were employed. The results of the limited investigation showed that both types of fields inhibited the formation of the detonation wave. The inhibition caused by a 30-gauss a-c field was found to be greater than that produced by a 1000-gauss d-c field with the magnet coils located in the same region of the induction zone. A theoretical analysis of the effect of a transverse magnetic field on a plane discontinuity surface with heat release was made. It was found that when the entire medium is assumed to be ionized, the changes across this discontinuity surface are found to be similar to that of a hydromagnetic shock problem, and when ionization is produced by the discontinuity surface and when a uniform transverse magnetic field is present in the entire fluid medium, the changes across the discontinuity surface are described by the equations for an ordinary detonation or deflagration wave. (auth)

10593 (BMI-1423) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING FEBRUARY 1960. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst., Columbus, Ohio). Mar. 1, 1960. Decl. Apr. 13, 1960. 94p. Contract W-7405-eng-92.

Preliminary results from electrical studies indicate that the "valence-compensated", air-fired U_3O_8-La_2O_3 solid solutions containing greater than equimolar amounts of La_2O_3 are poor conductors. Progress is reported on work devoted to fabrication and evaluation of U_3O_8 solid solutions containing 40, 50 and 60 mole % La_2O_3, and a sample containing 25 mole % Y_2O_3 and MgO each. In an investigation on the effects of combined ultrahigh pressure and high temperature on the uranium–oxygen system and on the reaction of the oxides with various mixed oxides, it was found that U_3O_8 has an oxygen-to-uranium ratio of $UO_{2.72}$. Corrosion testing of niobium alloys in 600 and 680°F water and 750°F 1500-psi steam was continued, and results for exposure times ranging up to 308 days are tabulated. In development of niobium–uranium fuels, corrosion test results were obtained in 224-day exposure to 600°F water and in 1500°F sodium for 500 hr. In investigations to improve the corrosion resistance and irradiation stability of thorium–uranium alloys, tensile and creep tests were performed at 600 and 700°C. In general fuel element development, techniques were developed for sub-bonding of niobium. In uranium dioxide compaction studies, results of flash roasting to attain off-stoichiometry uranium dioxide powders are tabulated. Progress is reported in the uranium carbide skull-casting process. In research on methods of preparing high-purity crystals of UO_2, success is reported by methods involving vapor deposition. The determination of iron by titration to a radiometric end point was found to be very sensitive to the concentration of the tartaric acid complexing agent and sodium acetate buffer. Esters of the methacrylate group were studied to determine the relation of total radiation dose and free-radical-site formation to ester-group structure. Stress-rupture tests are reported at 200°C and stresses of 7,000 to 11,000 psi on aluminum–35 wt.% uranium alloy and on similar alloys containing 2 and 3 wt.% tin or zirconium. Metallographic study of foiled titanium steam coil sections from Purex acid-recovery evaporator showed no structural differences which could account for the fracture; it is thought that failure was caused by mechanical rubbing. Results of 5000 Mwd/t uranium burnup in capsule specimens containing 4.8 wt.% carbon are comparable with those for 4.6 and 5.0 wt.% carbon specimens. Data from neutron activation studies of vapor-deposited Al_2O_3-clad uranium dioxide particles show that uranium contamination in the cladding surface probably accounts for the Xe^{133} release at low temperatures, and that claddings are not damaged during sphere fabrication or thermal cycling. Study of tantalum and its alloys under irradiation reveals alterations of properties such as strength and hardness, although ductility is not seriously impaired. Results of static tests in MTR of uranium dispersions in BeO or Al_2O_3 and dispersions of UC or UC_2 in graphite are tabulated. (For preceding period see BMI-1409.) (J.R.D.)

10594 (GRD-TN-60-632) THE DETECTION OF NUCLEAR EXPLOSIONS BY SEISMIC MEANS. Norman A. Haskell (Air Force Cambridge Research Labs., Bedford, Mass.). 1959. 28p.

Seismological factors that may enter into the detection of nuclear explosions by seismic means are discussed. The capabilities of various methods that may be used for the detection of nuclear explosions are discussed. It is pointed out that three types of elastic waves are possible in an isotropic solid body. They are classed as longitudinal on P waves; transverse or S waves; and surface waves, which propagate along the free surface of the solid body, in contrast to P and S waves, which propagate through the body of the solid. Of the various types of waves, the P wave is by far the most important for the purpose of detecting and identifying explosions. Topics discussed include the propagation of body waves and the need for discrimination between blasts and earthquakes. Methods used for the identification of earthquakes are described. (C.H.)

10595 (MND-P-2350) SNAP I RADIOISOTOPE-FUELED TURBOELECTRIC POWER CONVERSION SYSTEM SUMMARY, JANUARY 1957 TO JUNE 1959. Paul J. Dick

(Martin Co. Nuclear Div., Baltimore). June 1960. Contract AT(30-3)-217. 60p.

The SNAP I development program was initiated to develop a 500-watt turboelectric power conversion system for space applications. Superheated mercury vapor was used as the heat conversion working fluid. The conversion system was to obtain thermal energy from the decay of a radioisotope fuel such as Ce^{144}. Each of the major components and systems is summarized with respect to initial design objectives, development progress to the point of program termination, results obtained from tests and, where indicated, future growth potential. Reference is made to 10 other reports which describe, in detail, the major components of this power generating system. Also included is a bibliography of documented reports that are related to the power conversion system design criteria or system integration into a flight vehicle. (auth)

10596 (NP-9729) CONVENTION ON THIRD PARTY LIABILITY IN THE FIELD OF NUCLEAR ENERGY. (European Nuclear Energy Agency, Paris.) July 29, 1960. 67p. (In English and French)

A convention among the OEEC countries on the third-party liability in nuclear energy matters is presented. The purpose is to unify the basic rules regarding liability incurred for damage from nuclear incidents. Terms are defined, and 23 other articles are given dealing with liability in storage and transport of materials, compensation, and jurisdiction. (T.R.H.)

10597 (NP-9808) ASTRONAUTICS INFORMATION. OPEN LITERATURE SURVEY. VOLUME II, NUMBER 12 (Entries 23,311-23,514). California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Dec. 1960. 82p. Contract NASw-6.

The listings represent available information covering the period of Dec. 1960. The material is organized alphabetically according to subject. Cumulative subject and author indexes are included. About 200 references. (J.R.D.)

10598 (NP-9832) ASTRONAUTICS INFORMATION. Abstracts Vol. III, No. 1. Abstracts 3,082–3,184. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Jan. 1961. 34p. Contract NASw-6.

Abstracts are presented on astronautics. The abstracts are generally restricted to spaceflight and to applicable techniques and data. The publication covers the period of January 1961. 102 references. (J.R.D.)

10599 (NP-9849) A SURVEY OF THE URANIUM INDUSTRY IN CANADA, 1959. J. W. Griffith (Canada. Dept. of Mines and Technical Surveys). 1960. 49p.

Available as Can. Dept. Mines Tech. Surveys, Mineral Resources Inform. Circ. M.R. 44. $0.50.

A summary of the developments in the Canadian uranium industry for the year 1959 and some developments up to September 1960 is presented. Estimates of future production are given. Statistics on production for 1958 and 1959, ore reserves, costs, refining, prices, markets, world production and reserves, and a survey of thorium mining in Canada are outlined. (M.C.G.)

10600 (PIBAL-625) A REALISTIC APPROACH TO PROBLEMS OF OPTIMUM ROCKET TRAJECTORIES. Samuel E. Moskowitz and Lu Ting (Brooklyn. Polytechnic Inst.). October 1960. 17p. Project No. 9781, Contract AF49(638)-445.

An approximate method for analyzing problems of optimum rocket trajectories in a plane for which the vehicle experiences minimum flight time or attains maximum altitude is suggested. Included are such questions as an expedient form of the governing equations entering into the functional, when the maximum values of lift and drag forces are significant. It is established that, if terms of the order ϵ, $\epsilon \ll 1$ are neglected in the Euler-Lagrange equations (using two multipliers, with one shown to be initially of the order of ϵ and, hence, chosen initially to be zero), the computational efforts will be substantially reduced, and the extremum will differ from the true value by an order of ϵ^2. (auth)

10601 (SCTM-419-60(25)) INTEGRATING THE QUALITY CONTROL CONTRIBUTION IN RESEARCH AND DEVELOPMENT OPERATIONS. L. E. Snodgrass (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 17p.

Using the typical product growth cycle as a reference, the preproduction quality control contribution is discussed from the management viewpoint as a defect prevention tool. The idea that program success is largely dependent upon joint action by several engineering specialties is developed around the team approach and is related to some very basic engineering and management principles common to business operations. (auth)

10602 (TID-3702) INFORMAL LISTING OF BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Bibliographies Issued or in Progress During the Period, October–November 1960. (Office of Technical Information Extension, AEC). 29p.

10603 (TID-3703) INFORMAL LISTING OF BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Bibliographies Issued or in Progress During the Period December-January 1961. (Office of Technical Information Extension, AEC). 29p.

A list is presented of unclassified bibliographies of atomic energy literature issued or in progress during the period December 1960 through January 1961. (C.H.)

10604 (TID-11592) PROGRESS REPORT [ON NUCLEAR RESEARCH]. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). May 1, 1960. 151p. Contracts AT(30-1)-2098 and AT(30-1)-905.

Fission Element Chemistry Group: Studies on the analytical chemistry of various elements are reported along with fundamental investigations of electrode processes, luminescence, and separations. Estimates of mixed ligand complex formation constants for chloride–bromide, chloride–iodide, and bromide–iodide of mercury were obtained. Nuclear Chemistry (Inorganic) Group: Studies of ion exchange systems are reported which deal with invasion of anion exchanger by electrolyte precision volume measurement, of individual beads by photomicrography, and the properties of sorbed water. The ion-exchange equilibria with halogen ions, and effects of ion-exchange on the properties of astatine were also investigated. Progress is reported on studies of polonium and silver chemistry, solvent extraction of divalent halides, and on the use of tetraphenyl borate in alkali-metal extractions into nitrobenzene. Studies of deuteron reactions (d, He-3) were continued with particular attention to the reaction $Ar^{40}(d, He^3)Cl^{39}$. An empirical correlation for changes in the most probable charge for various types of fission is presented. The effects of nuclear shell structure on the yields of fission products in the mass region near $N \cong 50$ are reported. Targets of Th^{232}, U^{235}, and U^{238} were bombarded with deuterons and α particles of several energies and the yields of Kr^{85}, Kr^{87} and Kr^{88} were determined. Nuclear Chemistry (Organic) Group: Kinetic data on the acetalysis of triphenylmethyl bromide in benzene in the presence of 2,6-lutidine at 25° yield second-order rate constants which decrease markedly with increasing concentrations of acetic acid or 2,6-lutidine.

The decomposition of trimethylsulfonium perchlorate, picrate, or arenesulfonates in water solution at 138 to 158°C is kinetically first order. The rate exchange of hydrolytic hydrogens between H^3-labeled triphenyl-methanol and t-butanol in benzene solution at 25°C was measured in a flow system. Investigations were continued on the thermal decomposition of diaryldiazomethanes. A high degree of selectivity was observed in the free radical chain bromination of bibenzyl to meso-α,α'-dibromobibenzyl Cosmic Ray Group: In a study of the July 1959 solar flare, evidence was found that cosmic rays of rigidities >1 Bv had been produced. Progress in instrument design and component procurement for the satellite-borne γ radiation experiment is summarized. Other work was concerned with theoretical analysis of nuclear interactions at extreme cosmic ray energies and theoretical studies of cosmic and geocoronal plasmas. High Energy Accelerator Physics Group: Data are reported from studies of single quantum annihilation of positrons with K shell electrons of heavy elements. A study of strange particle decay mode continued, and an analytical study of 50,000 pictures of π^- is in progress. Linear Accelerator Group: Data on the cross sections for $Be^9(\gamma,n)$ are included. ONR Generator Group: Data from a $Se^{80}(p,p')$ reaction revealed high intensity peaks. Data are included on Se^{79}, Se^{80}, and Se^{81} energy levels, and on the $V^{51}(d,p)V^{52}$ reaction at 7.5 Mev. Design and use of a gas target with cylindrical window for use with a new multi-gap broad-range spectrograph are discussed. Deuteron scattering data from air targets were obtained on Ar^{40}, O^{16}, and N^{14}. Data from angular distribution in the reaction $Fe^{54}(d,n)Fe^{55}$ at an energy level of 7.5 Mev are tabulated. Radioactivity Group: Further progress is reported toward obtaining reliable measurements of g-values of short-lived excited states. A preliminary result was obtained for a rotational 2+ state in Hf^{180}. The gyromatic ratios of β-unstable manganese isotopes were studied. Techniques of recoilless resonance scattering are described together with a measurement to test parity conservation in strong interactions. Progress on experiments to determine the quadrupole and magnetic moment of the first excited state on Sn^{119} is outlined. Cyclotron Group: Results of data on the (γ,γ) and (γ,p) experiments are summarized. Theoretical Group: Studies were continued on field theory, the general theory of relativity, many body problems, meson theory, and low energy physics. (For preceding period see TID-5766.) (J.R.D.)

10605 (TID-11735) INFORMAL PROGRESS REPORT [ON METALLURGY AND CHEMISTRY], JANUARY, 1961. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). 4p.

The preirradiation inspection of 10 uranium-yttrium alloy specimens was completed. The test results of UF_4–Si–C reactions at 1625 and 1750°C are tabulated. Metallography studies showed a white second phase in the arc-melted products in addition to the UC, which accounted for 10 to 25 vol.% of the sample. Chemical analysis of Run 20 (at 1625°C) showed the presence of considerable excess silicon (1.37% in the reactor product) and a low fluoride content (0.04%). (B.O.G.)

10606 (UCRL-6179-T) DECOUPLING CONCEPTS AND PROJECT COWBOY. Glenn C. Werth (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 11, 1960. Contract W-7405-eng-48. 14p.

A brief résumé of the principal results of the Cowboy program is presented. The purpose of the Cowboy program was to use high explosives to test the decoupling theory. The Cowboy experiment verifies the prediction that explosions in elastic cavities will yield very small seismic signals, compared to fully tamped shots. The surface measurements and the close-in measurements are consistent with one another and with the decoupling theory. (W.L.H.)

10607 (UCRL-6202-T) HIGH-ENERGY, LOW-THRUST JUPITER MISSIONS. Robert H. Fox (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 31, 1960. 14p. Contract No. W-7405-eng-48.

Starting in the earth's orbit and with earth's velocity, calculations using higher energy transfer orbits for a mission to Jupiter are given. (T.R.H.)

10608 (UCRL-6295) NUCLEAR AND CHEMICAL EXPLOSIVE CRATERING EXPERIENCE APPLICABLE TO PLOWSHARE. Milo D. Nordyke (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 18, 1961. 25p. Contract W-7405-eng-48.

A brief review of nuclear cratering experiences and an outline of recent chemical cratering used to confirm theories are presented. To correlate the results, dimensional analysis indicated that a basic scaling law of $W^{1/3}$ is correct, where W is the weight of the explosive. Chemical cratering explosions and the Stagecoach program defined completely the depths-of-burst curves for desert alluvium from surface to containment depths. Preliminary results from the Scooter explosion indicated that $W^{1/3.4}$ scaling is adequate to predict crater dimensions. Data from the Buckboard program showed that it is unsatisfactory to use 1000-lb charges or smaller for cratering programs in hard-rock media. (M.C.G.)

10609 (UCRL-Trans-640(L)) EFFECTS OF EARTH CURRENTS PRODUCED BY ATOMIC HIGH ALTITUDE EXPLOSIONS. V. A. Troitskaya. Translated by D. A. Nimidoff from Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz, No. 9, 1321-7(1960). 20p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract No. 1598.

10610 ISOTOPE LABORATORY AT THE RESEARCH INSTITUTE FOR METALS INDUSTRY. Ernö Bujdosó. Energia és Atomtech., 13: 573-5(Dec. 1960). (In Hungarian)

In 1956, the Nonferrous Metals Branch of the Ministry of Heavy Industry and the Metals Industry Research Institute agreed to establish a radioisotope laboratory. By January 1959, the laboratory was ready to start its operations in the fields of metallurgy of nonferrous and light metals, chemical treatment methods, hot and cold working, and shaping of metals where the use of radioisotopes proves to be advantageous. The laboratory, which has a total area of 140 m^2, is located in a separate building; it contains a weighing room, preparatory areas, a hot laboratory for high-level operations, shops, offices, and sanitary installations. The hot laboratory is provided with the usual hot cells and glove boxes, underground storage areas, and shadow shields. The needed pressure gradient between hot and cold areas is maintained by a ventilating system that moves the air at a rate of 30 m/min. A 24-volt battery supplies the emergency power. (TTT)

10611 RADIOCARBON DATING. W. F. Libby (Univ. of California, Los Angeles). Science, 133: 621-9(Mar. 3, 1961).

The development of radiocarbon dating procedures is reviewed. Basic principles and counting techniques are discussed and a method is described for measuring the radioactivity of C^{14} directly. The sample is converted by chemical methods into a suitable form, such as carbon dioxide, acetylene gas, or solid carbon, which is placed inside a shielded Geiger or proportional counter, where it constitutes the gas or lies on the inner counter wall.

In this way a maximum count rate is achieved using relatively inexpensive equipment. Data are included on the natural abundance of radiocarbon in the earth, radiocarbon genesis and mixing, the activity of samples from the terrestrial biosphere, the radiocarbon content of various archeological specimens of known age, the age of a number of human occupation sites in America, and the age of a variety of archeological specimens as determined by radiocarbon dating procedures. Applications of radiocarbon dating procedures in the fields of archeology, geology, meteorology, and oceanography are discussed. (C.H.)

BIOLOGY AND MEDICINE

General and Miscellaneous

10612 (AD-237632) I. THE INFLUENCE OF TOTAL-BODY X-RAY ON THE KINETICS OF ERYTHROCYTE ENZYMES AS A BIOLOGICAL DOSIMETER. II. BIOCHEMICAL STUDIES ON BRAIN FROM RAT, RABBIT, GUINEA PIG AND MONKEY. Progress Report V, June 1, 1959 to May 31, 1960. Donald A. Rappoport (Baylor Univ., Houston, Tex. Coll. of Medicine). 101p. Contract DA-49-007-MD-428. (AFSWP-962)

Results are reported from a study of guanosine metabolism in tissues from the brains of guinea pigs that had received doses of 5000 and 7500 r to the head. The brains were removed at various time intervals postirradiation. No changes were noted in guanosine metabolism. Preliminary results are reported from studies of purine ribonucleoside dismutation by rat erythrocyte extracts. Data are included on the intermediary metabolism of guanosine, inosine, and adenosine in the presence of inorganic phosphate and extracts from rat erythrocytes. Findings are summarized from a study of the nature of phosphate esters and purine derivatives formed from the metabolism of guanosine, adenosine, and inosine by monkey brain extracts. Evidence is presented for the occurrence of a phosphoribomutase in these extracts. Data are included from a study of nucleoside metabolism by rat adrenal homogenates. (C.H.)

10613 (HW-66344(Rev)) A STUDY OF MORTALITY FROM CONGENITAL MALFORMATION FOR BENTON COUNTY, WASHINGTON. R. C. Henle (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 15, 1960. Contract AT(45-1)-1350. 27p.

A preliminary report (TID-8204) prepared for the U. S. Atomic Energy Commission suggests that the incidence of deaths due to congenital malformation might be related to the level of environmental radiation. From that report, it appears that the incidence of deaths due to congenital malformation was higher from 1952 through 1956 in Benton County, Washington (among other counties) than for the United States as a whole. The present report, resulting from an exhaustive study of the incidence of congenital malformation deaths in Benton County for the period 1949 through 1957, considers such factors as variation in the birth rates, death rates, and the age distributions of the populations. During 1949 through 1957, the ratios of congenital malformation deaths to live births averaged 0.51 for the nation, as compared to 0.48 for Benton County. The numbers of births per 1000 population averaged 24.5 for the nation and 29.1 for Benton County. The numbers of deaths per 1000 population averaged 9.5 for the nation and 4.7 for Benton County. Analysis of such factors shows that the incidence of congenital malformation deaths was not higher for Benton County than for the United States and demonstrates that the relation suggested in report TID-8204 concerning levels of natural radioactivity and incidence of congenital malformation deaths in the United States should not be accepted without first correcting for these factors for each county or state. (auth)

10614 (TID-11132) CANCER RESEARCH PROGRAM OF THE DIVISION OF BIOLOGY AND MEDICINE. (Division of Biology and Medicine, AEC). Nov. 1960. 100p.

The particular sphere of activity in oncological research of the Atomic Energy Commission is a circumscribed one embodying studies into the causes and prevention of cancer as an occupational hazard in atomic energy operations and, in addition, the development, with the tools of atomic energy, of new approaches to the study and treatment of cancer. The major portion of cancer research supported by the Atomic Energy Commission is conducted in seven major installations, five of which are associated with national laboratories or special AEC projects. In addition to these major facilities, modest research programs are supported at several universities, medical schools, and hospitals throughout the United States. The programs and facilities at these installations are reviewed briefly. (C.H.)

10615 (WRU-105) ANNUAL REPORT FOR PERIOD ENDING JUNE 30, 1960. Hymer L. Friedell (Western Reserve Univ., Cleveland. School of Medicine). [nd]. 115p. Contract W-31-109-eng-78.

Human uterine fibroblasts are cultured continuously. Data are presented from studies on the effect of irradiation on cell growth and on the progress of the mitotic cycle. Results are reported from studies on the protective effects of a number of chemical agents on the biological effects of x rays on fibroblasts grown in tissue culture. Procedures are described for measuring growth characteristics and mitotic rate in irradiated and unirradiated cultures. Results are included from an investigation of the influence of method of preparation and contamination in the assay of protein content and enzymatic activity of nuclear fractions from various tissues. Design features of a pulsed electron accelerator are described. Data are presented from tracer studies of purine metabolism in ascites tumor cells. Mechanisms involved in the stimulation of purine nucleotide synthesis by cytidine were studied in intact cells, as well as in cell-free systems. Results are included from a study on the effects on mortality of rats of surgical isolation of irradiated segments of the small intestine. Irradiation of 50% of the ileum of rats produced an acute intestinal syndrome with a mortality of 100% when the irradiated segment was left in continuity with the rest of the gut. When the irradiated segment was surgically isolated from the rest of the intestine, the syndrome did not develop. (C.H.)

10616 (JPRS-5863) PROSPECTS FOR THE USE OF RADIOISOTOPES IN CZECHOSLOVAKIA. Translation of "Radioizotopove Pracoviste ve Zdravotnictvi." K. Silink and S. Vohnout. Českoslov. Zdravot. 8, No. 2-3, 124-30 (1960) and "Projekce Radioizotopovych Laboratori pro Lekarskou Fakultu v Hradci Kralove." O. Steinbach. Českoslov. Zdravot. 8, No. 2-3. 131-8(1960). 36p.

Facilities of the Research Institute of Endocrinology for work with radioisotopes are described. Developments since 1951 are discussed. Applications of radioisotopes as tracers in metabolic studies and as localized agents of radiation in tumor therapy are reviewed. (C.H.)

10617 (JPRS-7666) CYTOLOGY. Translation of Tsitologiya, Volume II, No. 3, 1960. 208p.

10618 (JPRS-7666(p.177-81)) THE INJURIOUS EFFECT OF A MEDIUM IRRADIATED WITH X-RAYS DE-

PENDING ON THE TEMPERATURE. I. B. Smirnova. Translated from Tsitologiya, 2: No. 3, 371-3(1960).

Results are reported from an investigation of the influence of irradiated growth medium on the rate of division and the viability of irradiated paramecia. The effects of temperature during and after irradiation of the medium were also studied. It was concluded that the survival rate of paramecia does not depend on the temperature at which the medium is irradiated. Temperature did influence the interaction of the organisms and toxic products formed in the medium. (C.H.)

10619 THE PLACE OF INTERSTITIAL GAMMA-RAY EMITTERS IN RADIATION THERAPY. INDICATIONS–TECHNIQUE–EXAMPLES. Fernando G. Bloedorn, Carlo A. Cuccia, and Raul Mercado, Jr. (Univ. of Maryland, Baltimore). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 407-47(Mar. 1961).

Cobalt-60, Ce^{137}, Au^{198}, Ta^{182}, and Ir^{192} γ sources have been developed for use in interstitial irradiation of tumors. The flexible isotope sources are particularly suitable for extensive implants in flat, superficial areas which do not lend themselves to implantation with rigid radium needles. Indications, techniques, and examples of therapeutic uses of γ sources are presented. It is pointed out that the ideal approach is to have all types of radiation sources available and to use the one most appropriate for each case. A combined technique of treatment of head and neck tumors by external beam and interstitial therapy is described. Examples are also cited which illustrate that interstitial γ-ray therapy can be used where indications are unusual, giving good results with a minimum of late changes and without undue complications. (C.H.)

10620 INCIDENCE OF PELVIC MALIGNANCIES FOLLOWING IRRADIATION FOR BENIGN GYNECOLOGIC CONDITIONS. Philip Rubin, Anatol Ryplansky, and Arthur Dutton (Strong Memorial Hospital, Rochester, N. Y.). Am J. Roentgenol., Radium Therapy Nuclear Med., 85: 503-514 (Mar. 1961).

Results are reported from a survey on the incidence of pelvic malignancies in a group of 469 cases of benign gynecologic conditions irradiated by x rays or radium. The main group of patients was either menopausal or postmenopausal. Fourteen per cent were below the age of 40 and 4% were past the age of 55. It is pointed out that in selecting the method of treatment of benign gynecological conditions, morbidity and mortality of surgical procedures must be weighed against radiation therapy. The mortality from anesthesia and surgery is as high as that of late carcinogenesis. The complications of benign conditions, though not lethal, can be debilitating and distressing and are difficult to weigh against the morbidity associated with treatment. The total number of cases of malignancy following irradiation was 16, of which 12 were pelvic and 4 were extrapelvic in location. Brief case summaries are presented for the pelvic malignancies. No correlations were found between the incidence of these diverse tumors, the age of the patient, or type of radiation employed. The time interval before the onset of late cancer ranged from 4 to 15 years, with the average being 8 years. It is concluded that conservative policies should be used in the use of radiation therapy for the treatment of benign gynecologic conditions. (C.H.)

10621 CLOTTING CHANGES INDUCED BY METAL IONS IN VITRO. I. Šimonović, Krista Kostial, and Anica Maršić (Univ. of Zagreb and Inst. for Medical Research, Zagreb). Arhiv hig. rada i toksikol., 10: 227-34(1959). (In English)

Addition of UO_2^{2+}, Sr^{2+}, and Pb^{2+} to plasma in concentrations from 12.5 to 62.5 μg/ml does not influence the prothrombin activity. Mercury ions cause a prolongation of the plasma prothrombin time resulting in a reduction of the prothrombin index values to about 55%. This effect of mercury depends on the concentration of mercury ions and the exposure time. The highest reduction in prothrombin index values was observed at concentrations from 25.0 to 37.5 μg/ml after 3 hr of exposure. At higher or lower concentrations the effect was less pronounced. (auth)

10622 VARIATION OF RADIOCARBON CONCENTRATION IN MODERN WOOD. Kunihiko Kigoshi and Yoshio Tomikura (Gakushuin Univ., Tokyo). Bull. Chem. Soc. Japan, 33: 1576-80(Nov. 1960). (In English)

Results determined by using the carbon in tree rings of Japanese cedar trees are presented on the measurements of the atmospheric C^{14} increase in recent years. One tree was 177 years old, and the rings investigated covered the time span of 1782 to 1959. The analysis was carried out by counting acetylene formed from the wood carbon. It was found that (1) the C^{14} content is constant ±2% from 1782 to 1950, (2) a remarkable C^{14} increase occurred in the 1953 to 1959 range, (3) the samples from Tokyo, Akaita, and Mie show almost the same extent of increase after 1953, and (4) the C^{14} variations in the southern hemisphere follow those of the northern hemisphere, with a time lag of several months. (D.L.C.)

10623 EFFECT OF COLD EXPOSURE ON RESPIRATORY $C^{14}O_2$ PRODUCTION DURING INFUSION OF ALBUMIN-BOUND PALMITATE-1-C^{14} IN WHITE RATS. Roberto Masironi and Florent Depocas (National Research Council, Ottawa). Can. J. Biochem. and Physiol., 39: No. 2, 219-24(Feb. 1961). (NRC-6100)

Albumin palmitate-1-C^{14} complex was infused at a constant rate through a carotid cannula into otherwise intact nonfasted rats in environments at 30 or 6°C, after acclimation to 30 or 6°C. At 6°C, both warm- and cold-acclimated rats similarly exhaled as $C^{14}O_2$ a larger proportion of the injected C^{14} and gave lower terminal amounts of C^{14} in the extracted free fatty acids (FFA) of plasma than at 30°C. These results indicate that plasma FFA serve as substrate for cold-thermogenesis. Also, increased turnover and oxidation of FFA are not always inversely related to carbohydrate utilization but may be increased under conditions which result in concomitantly higher rates of turnover and oxidation of glucose. (auth)

10624 CARBON ISOTOPE FRACTIONATION DURING PHOTOSYNTHESIS. R. Park and S. Epstein (California Inst. of Tech., Pasadena). Geochim. et Cosmochim. Acta, 21: 110-26(1960). (In English)

A study was made of the reasons for isotopic fractionation in photosynthesis and the various factors controlling it. CO_2 samples from plants, air, and calcium carbonate were analyzed in a mass spectrometer in order to determine C^{13}/C^{12} and O^{18}/O^{16} ratios. The relative isotopic compositions of the samples and the fractionation factor between CO_2 and fixed plant carbon were determined. The effects of high light intensities on the fractionation factors of photosynthesis were studied. Results indicated that greater C^{12} enrichment occurred at high CO_2 concentrations and that light intensity was not important. Experiments on the extraction of "dissolved CO_2" and on the enzymic fixation of carbon dioxide suggested that the major fractionation of carbon isotopes in the photosynthetic fixation of atmospheric CO_2 is due to two steps. The first step involves the preferential uptake of C^{12} from the atmosphere and the second step the preferential conver-

sion of C^{12}-rich "dissolved CO_2" to phosphoglyceric acid, the first product of photosynthesis. Subsequent metabolism of photosynthetic products was accompanied by isotope fractionation. However, these fractionations affected the isotopic composition of only a few minor constituents of the plant. (M.C.G.)

10625 ANALYSIS OF TRITIUM INCORPORATION INTO INDIVIDUAL CELLS BY AUTORADIOGRAPHY OF SQUASH PREPARATIONS. Donald E. Wimber, Henry Quastler, Otto L. Stein, and Doris R. Wimber (Brookhaven National Lab., Upton, N. Y. and Montana State Univ., Missoula). J. Biophys. Biochem. Cytol., 8: 327-31(1960). (BNL-4718)

The relation between H^3 content of individual cells and grain count obtained in autoradiographs of squashed cells was investigated. The tissues used were root meristems of Tradescantia paludosa and intestinal epithelium of the mouse. The relation between grain count and tritium content is affected by self-absorption which depends on the thickness of the labeled cell. Therefore squashed preparations were sectioned to determine the uniformity of thickness of nuclei. In a preparation of mouse cells, thicknesses were $1.8 \pm 0.35\ \mu$, and in a preparation of Tradescantia cells, $2.97 \pm 0.35\ \mu$. The effects of similar and larger variations in thickness upon grain count were studied in material squashed with different pressures; no marked correlation was found. The lack of correlation is explained by the geometric relation between labeled nuclei and the emulsion. By counting grains and directly measuring H^3 content in a glass proportional counting tube in the same preparation, the yield of grains per disintegration was measured in Tradescantia cells and found to be 1 grain for 10.9 disintegrations with AR 10 autoradiographic film and 1 grain for 19.3 disintegrations for NTB nuclear track liquid emulsion. Latent image fading may pose a problem with long exposures; the conditions of its occurrence are as yet not well known. (auth)

10626 PITUITARY GIGANTISM IN A CHILD FIVE YEARS OF AGE: EFFECT OF X-RADIATION, ESTROGEN THERAPY AND SELF-IMPOSED STARVATION DIET DURING AN ELEVEN-YEAR PERIOD. Lewis M. Hurxthal (Lahey Clinic, Boston). J. Clin. Endocrinol. and Metabolism, 21: 343-53(Mar. 1961).

A case is presented of pituitary gigantism in a 5-year-old girl. The syndrome began at age 3, and was studied over a period of eleven years, from age 5 to age 16. X radiation had a transitory lowering effect on the growth rate and on the level of serum inorganic phosphorus. Estrogen therapy also decreased the growth rate to some extent, but the retardation became pronounced with the onset of anorexia nervosa due to a self-imposed starvation diet. (auth)

10627 ION ASSOCIATION. IV. EFFECT OF SODIUM SULFATE INFUSION ON RENAL CLEARANCE AND BODY RETENTION OF INJECTED RADIOSTRONTIUM IN DOGS. Mackenzie Walser, John W. Payne, and Ann A. Browder (Johns Hopkins Univ. School of Medicine, Baltimore, Md.). J. Clin. Invest., 40: 234-42(Feb. 1961).

Carrier-free isotopes of strontium, Sr^{85} and Sr^{89}, were injected intravenously into dogs. At intervals of 2.5 to 168 hr later, solutions containing sulfate were infused for 2 to 20 hr. The rate of urinary radiostrontium excretion immediately increased 6- to 40-fold. Radiostrontium clearance per 100 ml glomerular filtrate increased linearly with sulfate excretion. The fraction of filtered strontium excreted reached 80% as compared with a normal value of less than 10%. During sulfate infusion, 22 to 50% of the estimated amount of isotope remaining was excreted in the urine, provided that therapy was instituted within 18 hr of injection. When therapy was delayed, less than 15% of the remaining radiostrontium was removed. In half of the experiments, the amount of isotope excreted in the urine during sulfate infusion was more than twice the amount estimated to be in the extracellular fluid, indicating that deposits of radiostrontium were mobilized from the skeleton and/or the tissues. 46 references. (auth)

10628 THE INCORPORATION OF RADIOACTIVE PHOSPHORUS INTO THE PHOSPHOLIPIDS OF HUMAN LEUKEMIC LEUKOCYTES AND PLATELETS. Barry G. Firkin and William J. Williams (Washington Univ. School of Medicine, St. Louis). J. Clin. Invest., 40: 423-32(Feb. 1961).

The phospholipid composition of platelets and leukocytes from patients with acute and chronic leukemia was studied by a combination of column and paper chromatography. The phospholipid composition of these formed elements was similar and included phosphatidylethanolamine, phosphatidylserine, phosphatidylcholine, sphingomyelin, a phosphoinositide, (probably phosphatidylinositol), and a component believed to be phosphatidic acid. The incorporation of P^{32} into the leukocyte and platelet phospholipids of patients given $Na_2\text{-}HP^{32}O_4$ therapeutically was studied. Radioactivity was present in the phospholipids 18 hr after administration of P^{32} and was found principally in phosphatidylethanolamine, phosphatidylcholine, and the phosphoinositide. The in vitro incorporation of P^{32} into the phospholipids of leukemic leukocytes and platelets was also studied. The major incorporation of radioactivity occurred in the phosphoinositide and a component believed to be phosphatidic acid, in contrast to the pattern of labeling found in vivo. (auth)

10629 TRAINING FOR CLINICAL USE OF RADIOISOTOPES: QUALIFICATION COURSES. Ralph M. Kniseley (Oak Ridge Inst. of Nuclear Studies, Tenn.). J. Nuclear Med., 1: 239-50(Oct. 1960).

Courses to meet AEC requirements for medical uses of radioisotopes vary widely in content, structure, and length. Some goals and some minimum and desirable elements for courses have been proposed. In the three-week course given by the Medical Division of ORINS, special training aids facilitated the presentation of difficult basic information to physicians. (auth)

10630 THE SPREAD AND BINDING OF Ce^{144} IN THE BONE TISSUE. N. O. Razumovskiĭ and O. L. Tarchinskaya. Med. Radiol., 5: No. 11, 46-9(Nov. 1960). (In Russian)

Ce^{144} deposited in the bone tissue is almost completely revealed in its collagen fraction. In experiments in vitro during acetate buffer treatment of the bone, up to 20% of Ce^{144} could be removed; an almost complete removal of this isotope from the bone is feasible only when the latter is acted upon with hydrochloric acid. Trisodiocalcium salt of diethylenetriaminopentaacetic acid proved to be the most effective. (auth)

10631 PLUTONIUM DISTRIBUTION AND EXCRETION IN DOGS AT DIFFERENT PERIODS OF TIME. T. N. Rysina. Med. Radiol., 5: No. 11, 49-53(Nov. 1960). (In Russian)

A study has been made on plutonium distribution and excretion in dogs following a fourfold intravenous administration of $Pu(NO_3)_4$, totaling 0.2 μc/kg. Three months after the fourth injection, 73% of plutonium was found in the organism, of which 40% was in the skeleton and 30% was in the liver. During the subsequent $1\frac{1}{2}$ years, the plutonium level in the body remained unchanged, except for its discharge

from the spleen. By the end of the third year of observations, the amount of the radioactive element declined in all tissues, including the skeleton and liver. The total decrease thereof in the body comprised 17% of the dose introduced initially. Plutonium excretion was studied within the space of 1 year and 9 months. It reached its peak value during the first 3 to 4 days following injection (1.42 to 0.19%), then, at the end of the second year, it gradually diminished down to 0.005%. Beginning with the second week after introduction and throughout the first 6 months, it was being excreted in equal proportions with urine and feces; but, later on, the amount of plutonium carried by feces was 1.5 to 2 times lower than that excreted with urine. A possible method is shown enabling an approximate estimation of plutonium level in the organism by taking account of its activity in the excreta. (auth)

10632 THE STUDY OF THE THERAPEUTIC EFFECT OF SODIUM DIETHYLDITHIOCARBAMINATE IN POLONIUM AFFECTION. R. S. Krivchenkova. Med. Radiol., 5: No. 11, 53-6(Nov. 1960). (In Russian)

Experiments on mice, rats, and dogs showed that polonium (mice, 0.1 mc/kg; rats, 0.075 mc/kg; and dogs, 0.05 mc/kg) provoked in the animals an acute radiation sickness, with lethal termination on the 11 to 40th day. The experiments show that the administration of sodium diethyldithiocarbaminate 1 hr after the affection in a dose of 200 mg/kg subcutaneously and intravenously accelerates polonium excretion from the organism of mice and rats approximately by two times. The average life expectation of the animals treated rises 2 to 3 times, as compared with the controls. After the introduction of sodium diethyldithiocarbaminate to dogs, no clearly marked acceleration of polonium excretion through the gastrointestinal tract could be revealed, although the average life span of the treated dogs was 2 to 3 times higher than that in the controls. (auth)

10633 CRITICAL ASSESSMENT OF THE IMPORTANCE OF INITIAL SIGNS OF IRRADIATION CATARACT. N. A. Vishnevskiĭ, V. M. Abdullaeva, E. I. Ivanova, E. S. Kotova, S. I. Krotova, and V. N. Stiksova. Med. Radiol., 5: No. 11, 77-81(Nov. 1960). (In Russian)

Observations were conducted on the changes of the crystalline lens seen upon biomicroscopic examination in practically healthy persons of varying age who were not subjected to the action of ionizing radiation (914 persons, 811 adults and 103 children). For the purpose of diagnosing irradiation cataract and eliminating diseases, during which the so-called "complicated cataracts" are observed, the following information is deemed necessary: a thorough examination by different specialists; the presence of occupational characteristics, with the indication of exposure to ionizing radiation, as well as data of radiation dose values; and ophthalmoscopic examination with meticulous biomicroscopy. (auth)

10634 BACTERIURIA IN A HEALTHY POPULATION AND ITS RELATION TO HYPERTENSION AND PYELONEPHRITIS. Sam Switzer (Atomic Bomb Casualty Commission, Hiroshima-Nagasaki, Japan). New Engl. J. Med., 264: 7-10(Jan. 5, 1961).

A nonhospital Japanese population comprising 428 hypertensive and 516 nonhypertensize subjects was screened for bacteriuria and pyelonephritis. Bacteriuria was rarely found in men but occurred in women with increasing frequency past middle age, reaching a prevalence of 6.3% in the seventh decade. No relation could be demonstrated between bacteriuria and hypertension. It is suggested that if pyelonephritis causes hypertension, this is a rare event and is not detectable in a random sampling of hypertensive subjects. (auth)

10635 THIAZOLIDINES AND AMINOALKYLTHIOSULFURIC ACIDS AS PROTECTING AGENTS AGAINST IONIZING RADIATION. A. Kaluszyner, P. Czerniak, and Ernst D. Bergmann (Ministry of Defence, Tel-Hashomer, Israel and Government Hospital, Tel-Hashomer, Israel). Radiation Research, 14: 23-8(Jan. 1961).

A number of substituted thiazolidines and some aminoalkylthiosulfuric acids were shown to effect protection against ionizing radiation approximately as well as cysteamine. It appears possible that this activity is due to decomposition of the compounds into the corresponding mercaptoamines. (auth)

10636 ESTIMATION OF RADIATION DOSAGE DELIVERED BY A SINGLE MASSIVE INJECTION OF I^{131} IN THE RAT. Patricia W. Durbin, George D. Barr, Marilyn H. Williams, Nylan Jeung, and Muriel E. Johnston (Univ. of California, Berkeley). Radiation Research, 14: 149-66 (Feb. 1961). (UCRL-9256-R).

Young adult female Sprague-Dawley rats were injected with I^{131} at levels of 1, 10, 50, and 90 $\mu c/g$ body weight. Retention of I^{131} was determined by in vivo counting for 2 weeks after injection. Fifty rats injected with 50 $\mu c/g$ of I^{131} were serially sacrificed at intervals from 4 hr to 6 days later. Tissue weights and I^{131} concentrations were determined, and β- and γ-ray doses were calculated for the whole body and several tissues. The internal radiation significantly altered both release of I^{131} from the thyroid gland and gastrointestinal metabolism of radioiodine. The thyroid glands of the high-dose rats accumulated I^{131} normally for the first 12 hr. After the twelfth hour the heavily irradiated thyroid tissue lost I^{131} rapidly, so that within a short time all the accumulated I^{131} had been returned to the circulation. When the rapid release of I^{131} from the irradiated thyroid was taken into account, the calculated β-ray dose to the gland was 25% of that which would be calculated from tracer studies. Gastric motility was reduced during the first 36 hr after the I^{131} injection, causing a significant delay in reabsorption of I^{131} from the intestine. Prolonged whole-body retention of I^{131} and elevated tissue I^{131} concentrations could be accounted for by delayed reabsorption of I^{131} secreted by the stomach, and by the release of I^{131} from the thyroid. The γ-ray contribution to the total dose was significant, 15 to 30% of the total dose in the whole body and in all tissues except the thyroid and gastric mucosa. The total radiation dose in the whole body and the doses calculated for the individual tissues from a single high-level injection of I^{131} were generally consistent with previous observations on lethality and pathology of long-term survivors. It is suggested that the pathologic changes previously observed in long-term survivors of a single massive injection of I^{131} are not due to either radiation or endocrine deficiency alone but are the consequences of both radiation damage and profound and prolonged endocrine deficiency. (auth)

10637 THE USE OF MAMMALIAN CELLS TO EVALUATE THE EFFECTIVENESS OF AGENTS FOR PREVENTING RADIATION DAMAGE. METHOD BASED ON FORMATION OF CLONES AND MONOLAYERS. George G. Kelley and Glynn P. Wheeler (Southern Research Inst., Birmingham, Ala.). Radiation Research, 14: 174-83(Feb. 1961).

A practical method of using mammalian cells in tissue culture for evaluating candidate radiation-protective agents was demonstrated. The viability of the cells was determined by counting clones or by observing the extent of for-

mation of monolayers. The method can be used to determine quantitative differences in the degrees of protection afforded by various compounds. (auth)

10638 A RAPID SCREENING METHOD FOR I^{131} FAT-ABSORPTION TEST. Leonard Rosenthall (Univ. of Chicago). Radiology, 76: 251-4(Feb. 1961).

The usual method for determining small-bowel absorbability of an oral test dose of I^{131}-tagged triolein is to take blood samples 3, 4, 5, and 6 hr after ingestion. The total blood activity in terms of percentage of administered dose is then compared with normal values. Malabsorption is considered to exist when blood activity falls below the normal range. Impairment of the body's ability to metabolize the absorbed fat is postulated when the blood activity is high and renal function is normal. Early in our routine clinical use of this test it was learned that, with oral doses of about 20 μ, enough activity was present in the blood at the end of 3 hr to be counted by means of a scintillation detector probe placed against the head. Further, a linear relationship was found to exist between the number of microcuries in the blood and the head counts. This latter finding enables reasonably accurate determination of the percentage of administered dose present in the blood without venipuncture. The examination is terminated in those patients with head counts corresponding to normal levels of absorption at the end of 3 hr. Venipuncture blood sampling is done at 4, 5, and 6 hr in patients with head counts indicating low blood activity at the third hour. (auth)

10639 IN VITRO EFFECTS OF IRRADIATION COMBINED WITH ACTINOMYCIN D. Paul Y. M. Chan and Edwin J. Liebner (Univ. of Illinois, Coll. of Medicine, Chicago). Radiology, 76: 273-4(Feb. 1961).

A potentiating effect of actinomycin D on x rays was demonstrated in HeLa cells in tissue culture. Protein determinations were used as an index of quantitative cellular growth. The combination of drug and radiations gave 50 to 58% of normal protein values. The method described is recommended for investigations and comparisons of various combinations of irradiations and drugs as to their effect on cancer growth before clinical trials. (C.H.)

10640 MULTIPLE IMPLANT DOSIMETRY. C. G. Amato, S. J. Malsky, V. P. Bond, and B. Roswit (Brookhaven National Lab., Upton, N. Y.). Radiology, 76: 292-4(Feb. 1961).

Low-atomic-number silver-activated radiophotoluminescent glass-needle dosimeters were placed within a four-portal 10-mil wall gold shield and implanted in a dog. Implants were made in three planes so that most of the vital organs were pierced. The dog was exposed to 260-kvp x rays, and was turned over at mix-exposure so that total exposure was obtained. Preliminary results indicate the feasibility of this mode of multiple implant dosimetry for the confirmation of isodose patterns and depth-dose measurements. (C.H.)

10641 THE ELIMINATION OF URIC ACID IN MAN, STUDIED BY MEANS OF C^{14}-LABELED URIC ACID. Leif Bøge Sørensen. Scand. J. Clin. & Lab. Invest., 12: Suppl. No. 54, 1-214(1960). (In English)

Studies were made of the total amount of uric acid in the human body and the turnover rate. Uric acid labeled with C^{14} was used as a tracer. A comparison of the amount of uric acid turned over per day with the amount excreted in the urine made it clear that a considerable part of uric acid is eliminated by some other route than through the kidney. Results are reported from studies on the extrarenal excretion of uric acid. (C.H.)

10642 EFFECT OF DEUTERIUM SUBSTITUTION IN SYMPATHOMIMETIC AMINES ON ADRENERGIC RESPONSES. B. Belleau, J. Burba, M. Pindell, and J. Reiffenstein (Univ. of Ottawa). Science, 133: 102-4(Jan. 13, 1961).

It was discovered that replacement of the α-hydrogens of tyramine and tryptamine by deuterium produces a marked intensification of the blood pressure effects and nictitating membrane contraction normally produced by these amines. The results are interpreted on the basis of kinetic isotope effects at the level of monoamine oxidase and clearly establish the importance of this enzyme in the limitation of response when tyramine and tryptamine are involved. The observed deuterium isotope effects with α,α-bisdeuterotyramine (α,α-D_2-tyramine) have been reproduced with only one of the optical isomers of monodeuterotyramine. This establishes that the enzyme displays a high degree of optical specificity. The use of l-bisdeuteronorepinephrine revealed that norepinephrine cannot be attacked by the enzyme at the effector cell level. (auth)

10643 ELECTRORETINOGRAM IN RESPONSE TO X-RAY STIMULATION. C. S. Bachofer and S. Esperance Wittry (Univ. of Notre Dame, Ind.). Science, 133: 642-4 (Mar. 3, 1961).

The retina of the grass frog, Rana pipiens, responds to flashes of high-intensity x rays and produces an electroretinogram indistinguishable in form from the electroretinogram produced in response to light stimulation at low and intermediate intensities. At higher intensities the form changes and, for maximal responses, the electroretinogram in response to x rays shows a lower amplitude and a longer latent period than that in response to light. The prolonged latent period indicates additional intermediate reactions for the x-ray response. (auth)

10644 BIOLOGICAL PROBLEMS AND COSMIC FLIGHTS. N. M. Sisakyana. Vestnik Akad. Nauk S.S.S.R., 30: 15-24(Nov. 1960). (In Russian)

The information obtained on biological problems in space flight is reviewed and generalized. A detailed study of numerous cytological, genetic, and microbiological factors was made on various bacteria, flies, mice, and dogs (Belka and Strelka) which were returned to earth alive after being launched into space on May 15th, 1960. No specific radiation effects could be detected. The effect of weightlessness on various physiological functions such as pulse rate, heart pressure, etc., was found to be minor in nature. The effect of noise, vibration, and acceleration was essentially the same as that found from experiments on earth. The pressure in the sealed cabin could be varied from 760 to 405 mm at a partial pressure of oxygen of 160 mm. It was found to be difficult to maintain the required temperature in the cabin because convective heat-transfer processes could not be employed in space. Heat transfer took place by a radiative mechanism. All these results are being evaluated with the purpose of putting a man into space for an extended period of time. (TTT)

10645 THE APPLICATION OF RADIOISOTOPES IN BIOLOGY. A. M. Kuzin (International Atomic Energy Agency, Vienna). Review Series, Developments in the Peaceful Applications of Nuclear Energy. No. 7. 63p. (1960). (STI/PUB/15/7). (In Russian and English)

This survey of the ways in which radioisotopes are used in biology will give the reader an idea of the most promising trends in the use of this new method of investigation in the various branches of biology. It is based on work pub-

lished in 1959 and illustrates the application of radioactive tracers to biochemistry, plant and animal physiology, microbiology and immunology, histomorphological research, hydrobiology, entomology, ichthyology, genetics, and other biological disciplines, and gives a complete picture of the use of isotopes in biology. A bibliography of 570 references is attached, covering articles, books, and monographs in which the reader can find information about the ways in which radioactive isotopes are used in biological research and for practical economic purposes. (auth)

Biochemistry, Nutrition, and Toxicology

10646 (TID-11157) A STUDY OF STRONTIUM, CALCIUM, AND RARE EARTH METABOLISM IN HUMANS. Annual Report for December 1, 1959 to November 30, 1960. Herta Spencer (Montefiore Hospital, New York). Oct. 10, 1960. 121p. Contract AT(30-1)-1763.

Studies on the metabolism of Sr^{85} in man were continued under strictly controlled dietary conditions. Data are included on the enhancement of radiostrontium excretion; the comparative effect of stable strontium and of stable calcium on radiostrontium excretion; the effects of changes in the calcium to phosphorus ratio on strontium uptake; and the effect of prolonged high calcium intake on the uptake of Sr^{85} in man. Studies on Sr^{90} metabolism were carried out in 10 normal, healthy young persons under controlled dietary conditions. Data are tabulated. Results are included from studies on the tissue distribution and excretion of radioisotopes of scandium, yttrium, and samarium administered in ionic and chelated form to mice; the absorption of Ca^{14}-labeled chelating agents in man; and the tissue distribution and excretion of Cs^{137} in mice and man. (C.H.)

10647 (TID-11699) COMPARATIVE TOXICITY OF STABLE RARE EARTH COMPOUNDS. Progress Report for 1960. (Iowa. State Univ., Iowa City). 5p.

Progress is reported in the development and maintenance of a program for the study of the comparative toxicity of stable rare-earth compounds following chronic exposure of laboratory animals. Gadolinium, dysprosium, praseodymium, cerium, ytterbium, and yttrium were used in implantation studies in mice. Oral feeding experiments in mice were conducted with gadolinium, neodymium, dysprosium, cerium, ytterbium, and yttrium. Inhalation studies in rats and guinea pigs are reported in progress. The effects of various doses of cerium citrate, chloride, and ethylenediaminetetraacetic acid were investigated in dogs. No results are included. (C.H.)

10648 (CEA-tr-A-734) CONSIDERATIONS PHYSICO-CHIMIQUES SUR L'ELIMINATION DES METAUX RADIOACTIFS PAR LES CHELATANTS. (Physicochemical Considerations in the Elimination of Radioactive Metals by Chelates). H. Y. Heller and A. Catsch. Translated into French from Strahlentherapie, 109: 464-82(1959). 38p.

An attempt at a simple semi-quantitative description of the conditions for elimination of radioactive metals from the body by low-molecular-weight chelates is presented. The study considers the known mechanisms of biological differentiation, but without resorting to specific chelations for the living organism. This representation does not take into account the fact that the role of complexes reaching an equilibrium agree satisfactorily with actual experimental data. (tr-auth)

10649 AN AUTORADIOGRAPHIC STUDY OF THE EPIPHYSEAL CARTILAGE IN PAPAIN-TREATED RABBITS AFTER ADMINISTRATION OF RADIOSULPHATE. B. Engfeldt and O. Westerborn (Univ. of Uppsala). Acta Pathol. Microbiol. Scand., 49: 55-72(1960). (In English)

Results are reported from an autoradiographic study of epiphyseal cartilage using radiosulfate in rabbits treated with papain. With the aid of the stripping film technique, a detailed study was made on the cellular level, with special consideration to early changes. The results of the investigation confirmed the conclusion based on results from earlier studies that papain acts directly upon the cartilage cells. The findings observed may result from damage to the cell or to its permeability. The results of the investigation also suggest that the effect of papain continues for about 20 hr after injection, followed by a reparative phase. Seven days after injection of papain the cartilage cells and matrix appear to function normally as regards their uptake of S^{35}, although considerable morphologic changes persist. The chondroitin sulfate, which at the time of papain injection is located in the metaphyseal cartilage remnants enclosed by bone, does not appear to be affected by papain. It would seem that bone deposits or calcification afford a protection against the effect of papain. (auth)

10650 AN AUTORADIOGRAPHIC STUDY OF THE EPIPHYSEAL CARTILAGE IN NORMAL RABBITS AFTER ADMINISTRATION OF RADIOSULPHATE. B. Engfeldt and O. Westerborn (Univ. of Uppsala). Acta Pathol. Microbiol. Scand., 49: 73-81(1960). (In English)

An autoradiographic examination of epiphyseal cartilage in young rabbits after administration of radiosulfate is reported. The activity 2 hr after the injection of S^{35} is seen exclusively in the cells. After 24 hr the activity is seen in the cell periphery and the surrounding matrix. Seven days after the injection of S^{35} the matrix is diffusely labeled. In the metaphysis equally strong labeling is seen in the bone trabeculae close to the epiphysis. After 2 to 3 weeks one can observe a weak reaction in the cartilage matrix and in the trabeculae of the metaphysis. The experiments seem to demonstrate that the chondroitin sulfate of cartilage matrix is synthetized in the chondrocytes. (auth)

10651 THE INFLUENCE OF RADIOACTIVITY AND LUNG BURDEN ON THE PULMONARY CLEARANCE RATE OF BARIUM SULFATE. H. Cember, J. A. Watson, and M. E. Novak (Univ. of Pittsburgh). Am. Ind. Hyg. Assoc. J., 22: 27-32(Feb. 1961).

Parallel groups of rats were injected intratracheally with radioactive and nonradioactive barium sulfate particles which had a geometric mean size of 3.6 μ. Dose levels were 23.3, 233, and 2330 μg. Lung clearance was found to be exponential in time. All doses had a clearance half-time of about 10 days, except the 2330 μg radioactive dose for which the half-time was 27.5 days. (auth)

10652 THE QUINOLINE PATHWAY OF TRYPTOPHAN OXIDATION IN PSEUDOMONAS: SYNTHESIS OF 7,8-DIHYDROXYKYNURENIC ACID AND KYNURENIC ACID-C^{14}. Takehiko Tanaka and E. J. Behrman (New England Deaconess Hospital, Boston). Anal. Biochem., 1: 181-6(1960).

The enzymic synthesis of kynurenic acids-2- and 3-C^{14} from the correspondingly labeled tryptophans is described. The method utilized successive treatment with tryptophan pyrrolase, formamidase, and L-amino acid oxidase. 7,8-dihydroxykynurenic acid was synthesized by application of the Conrad-Limpach method to 2,3-dimethoxyaniline and diethyloxalacetate. These compounds are of importance in the elucidation of the pathway of tryptophan metabolism by certain bacteria of the Pseudomonas species group. (auth)

10653 THE EFFECTS OF DEUTERIUM OXIDE ON CERTAIN MICROORGANISMS. Rosalie De Giovanni (Co-

lumbia Univ., New York). Ann. N. Y. Acad. Sci., 84: 644-7 (Nov. 25, 1960).

The growth of several strains of E. coli and B. subtilis was inhibited by the presence of D_2O; the degree of inhibition exhibited by each strain was specific. The addition of 0.5% NaCl to the D_2O media decreased the inhibition of growth. A deuterium-resistant mutant was obtained from one strain of E. coli. The incorporation of deuterium induces not only phenotypic but also genotypic changes in microorganisms. The effects induced by deuterium depend, however, on the genotype of the strain. The isotope appears to be mutagenic for some strains and some loci but not for others. Various types of forward mutations were obtained in some of the bacterial strains tested, and the frequency of backward mutation was increased in two strains exposed to deuterium. Thymine containing deuterium, possibly in its methyl group, is not capable of inducing any detectable changes in a thymine requiring mutant. Cells, grown in D_2O media and subsequently washed and irradiated in H_2O-saline, are more sensitive to ultraviolet irradiation than control cells. (auth)

10654 CULTIVATION OF MICROORGANISMS IN HEAVY WATER. Henry L. Crespi, Sylvia M. Conrad, Robert A. Uphaus, and Joseph J. Katz (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 648-66(Nov. 25, 1960).

Data are presented on the culture of a variety of algae and other microorganisms in highly deuterated systems. Growth rates for the unicellular green algae Scenedesmus obliquus and Chlorella vulgaris in 99.6% D_2O were improved so that they approach one-half the rates in H_2O nutrient media. S. obliquus was also successfully mass cultured in 5-liter units. The blue-green alga Plectonema calothricoides was grown on a continuous laboratory scale in 99.6% D_2O. A number of other green, blue-green, and red algae and diatoms have been cultured at D_2O levels from 75 to 99.6%. The bacterium Escherichia coli, the yeast Torulopsis utilis, and the mold fungus Aspergillus niger were grown in fully deuterated media. Protozoa have been cultured at somewhat lower D_2O concentrations: Paramecium caudatum routinely in 60% D_2O lettuce infusion and Paramecium bursaria in 50% lettuce infusion. In general, algae are best adapted to D_2O by serial subculture, 0 to 75 to 99 to 99.6% D_2O, but Chlorella, E. coli, T. utilis, and A. niger can be grown by direct transfer from H_2O to 99.6% D_2O nutrient media. (auth)

10655 THE EFFECT OF DEUTERIUM OXIDE ON VIRUS-HOST INTERACTION. Lionel A. Manson, Richard I. Carp, Vittorio Defendi, Edward L. Rothstein, Richard W. Hartzell, Jr., and David Kritchevsky (Wistar Inst. of Anatomy and Biology, Philadelphia). Ann. N. Y. Acad. Sci., 84: 685-94(Nov. 25, 1960).

The effect of D_2O on the growth of E. coli and a number of mammalian stable cell lines has been investigated. As the D_2O concentration was increased, the cells of all the species tested appeared larger, showed an increase in water content and dry weight, and had a slower growth rate. Cytological investigations showed an increase in the number of multinucleated cells and a moderate increase in sudanophilic material. In general, cells grown in D_2O exhibited cytological characteristics similar to those observed in giant cells produced by irradiation. The effect of D_2O on bacteriophage replication was examined. The burst size of T5 was somewhat reduced in deuterated E. coli, but the burst size of T7 was significantly increased. These differences might be explained by the fact that whereas the bulk of T5 DNA is derived from the medium, most of the T7 DNA is derived from the host. With increased size of the host, more DNA and protein production might be expected. Whether or not deuteration causes an inhibition of the uptake of various substrates from the medium is under investigation. Studies of the multiplication of poliovirus in deuterated HeLa and monkey kidney cells also showed a marked increase in burst size. A possible variant of CHAT (attenuated type 1 poliovirus) was isolated from virus progeny grown in deuterated monkey kidney cells. The reason for the increased burst size in deuterated cells is not clear at the present time. Similar increases in burst size were observed in studies of viral replication in x ray treated giant cells. It is possible that the enlargement of cells grown in D_2O is the underlying factor in the observed increase of poliovirus burst size. (auth)

10656 HEPATIC LIPOGENESIS IN D_2O-FED MICE. Joseph L. Rabinowitz, Vittorio Defendi, John Langan, and David Kritchevsky (Veterans Administration Hospital, Philadelphia and Wistar Inst. of Anatomy and Biology, Philadelphia). Ann. N. Y. Acad. Sci., 84: 727-35(Nov. 25, 1960).

Swiss mice were maintained on a regimen of 25% D_2O for three weeks. The mice were slightly smaller than H_2O-fed controls, but the liver weight to body weight ratio was greater. There were no significant differences in liver lipid or cholesterol. Histologic examination showed progressive vacuolization and loss of basophilia, with changes in the mitochondrial distribution in the cytoplasm. These alterations did not show any specific localization in the hepatic lobule. There was a progressive reduction in the ability of liver homogenates from D_2O-fed mice to convert acetate-2-C-14 to cholesterol and fatty acid. Incubation of normal mouse livers in media containing 75% D_2O resulted in significant enhancement of cholesterol and fatty acid biosynthetic capacity. This reduced lipogenesis in D_2O-fed mice appears to be due to derangements in cell structure, rather than to inhibition of enzyme activity. (auth)

10657 PHYSIOLOGICAL EFFECTS OF D_2O IN MAMMALS. John F. Thomson (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 736-44(Nov. 25, 1960).

Rats drinking D_2O died when about one-third of their body water was replaced by D_2O. Hypophysectomized animals were considerably more sensitive to D_2O than were normal rats. Evidence was obtained for impairment of kidney function, anemia, disturbed carbohydrate metabolism, central nervous system disturbances, and altered adrenal function; no specific cause of death can be definitely stated at the present time. Studies on the effects of D_2O on mammalian enzymes in vivo and in vitro have indicated a number of changes, few of which by themselves seem to be of much consequence. It seems probable that the toxic action of D_2O is attributable to the summation of many small changes in rates of enzymatic reactions in the body. (auth)

10658 EFFECT OF DEUTERIUM OXIDE ON THE REPRODUCTIVE POTENTIAL OF MICE. Dorice M. Czajka and Asher J. Finkel (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 770-9(Nov. 25, 1960).

Replacement of hydrogen with deuterium by the administration of 25% D_2O in the drinking water resulted in certain alterations in the reproductive potential of female mice. These changes included an apparent decrease in the number of pregnancies carried close to term, an increase in the incidence of wholly nonviable litters, and a decrease in the survival of newborn mice. Examination of uterine contents late in pregnancy, however, revealed that neither

the incidence of pregnancy nor the mean number of implanted embryos per pregnant female was correlated with the duration of deuteration. Reduction of the incidence of viable newborn mice in part reflected the increase in nonviability of fetuses examined in utero late in gestation and in part may have been the result of maternal cannibalism. Reduction of fetal viability was greatest when the dams had been substantially deuterated at the time of implantation of the fetus, which occurred at about the fifth day after mating. When the administration of deuterium to female mice preceded mating by 1 week, the higher the level of deuteration, the lower was the total fetal viability. A critical level appeared to exist here between 25 and 30 at.% deuterium in the drinking water, above which fetal viability ceased. The reduction of mean litter size and of viability of the newborn was at least partly reversible by restoring the dams to ordinary drinking water. (auth)

10659 A COOPERATIVE ASSAY OF A SAMPLE WITH ERYTHROPOIETIC STIMULATING ACTIVITY. Geoffrey Keighley, Peter H. Lowy, Henry Borsook, Eugene Goldwasser, Albert S. Gordon, Theodore C. Prentice, Walter A. Rambach, Frederick Stohlman, Jr., and Donald C. Van Dyke. Blood, 16: 1424-32(Oct. 1960).

A batch of erythropoietically active material made from the plasma of phenylhydrazine-treated rabbits was distributed to seven laboratories for the purpose of comparing assay methods. The results of the assays using 10 different methods or major variations are presented. Most of the assay methods being employed were represented so that other laboratories should be able to compare their results to those obtained in this study. The importance of obtaining some uniform basis for comparison of activity of erythrocyte stimulating factor between laboratories was emphasized and a tentative unit was proposed based on a net incorporation into rat red cells of 20% of injected Fe^{59}, using a standardized assay procedure. (auth)

10660 METABOLISM OF RADIOIODINE BY CAT FETUS NEAR TERM. André Vérain and Alice Vérain-Pinoy (Faculté mixte de Médecine et Pharmacie, Algiers). Compt. rend., 251: 3079-81(Dec. 19, 1960). (In French)

The chromatographic study of the thyroids of cats and the fetus near term has shown a higher specific radioactivity in the fetus than in the mother and a similar iodine metabolism. There is a hormone ratio, of the same order as the metabolism ratio, of iodide equal to or slightly higher than one, except for some individuals in which it is sharply lowered. (tr-auth)

10661 EFFECTS OF HEAVY WATER ON THE DEVELOPMENT OF POLIO VIRUS AS A FUNCTION OF TEMPERATURE. André Lwoff and Marguerite Lwoff (Institut Pasteur, Paris). Compt. rend., 251: 3131-2(Dec. 19, 1960). (In French)

Heavy water modifies the speed of development and the infectious particle yield of the polio virus. These two effects are dependent on four factors: the temperature, the heavy water concentration, the moment when it is used, and the genotype of the virus stock. (tr-auth)

10662 THE UPTAKE OF DIVALENT MANGANESE ION BY MATURE NORMAL HUMAN RED BLOOD CELLS. Robert I. Weed and Aser Rothstein (Univ. of Rochester, N. Y.). J. Gen. Physiol., 44: 301-14(Nov. 1960).

At physiological pH and concentrations of Mn^{2+} in excess of 5×10^{-4} M, study of the Mn^{2+} ion movement into human red cells is complicated by physicochemical alterations of the ion itself. At concentrations below 5×10^{-4} M, the rate of uptake bears a linear relationship to the Mn^{2+} concentration. The permeability constant for inward movement of Mn^{2+} is 2.87 ± 0.13 (S.E.) $\times 10^{-9}$ cm/sec. The rate is not influenced by the addition of metabolic substrates such as glucose or adenosine or the metabolic inhibitors iodoacetate or fluoride. Co^{2+}, Ca^{2+}, and Mg^{2+} do not appear to compete with Mn^{2+} for entry, but at high concentrations relative to Mn^{2+}, they reduce the rate of entry. Ca^{2+} is far more effective than Co^{2+} or Mg^{2+} in this regard. The permeability constant for outward Mn^{2+} movement is 1.38 ± 0.21 (S.E.) $\times 10^{-9}$ cm/sec, about half of that for entry. This slower rate of outward movement is consistent with the finding that 40 to 60% of the Mn^{2+} taken up by the red cells is non-ultrafilterable. Less than 5 to 10% of the Mn^{2+} appears to be bound to the stroma. It is concluded that entry and exit of Mn^{2+} is a process of passive diffusion involving no carriers, transport, or metabolic linkage. (auth)

10663 STUDIES AND EXPERIMENTS IN RADIOMICROBIOLOGY. ASSIMILATION OF Fe^{59}, I^{131}, P^{32}, AND S^{35} BY STAPHYLOCOCCUS ENTEROTOXICUS. C. Arghittu (C.A.M.E.N., Livorno, Italy). Minerva Nucleare, 4: 313-15(Nov. 1960). (In Italian)

The value of radioisotopic techniques in the field of microbiology was illustrated, and the technique was used to determine the radioactive uptake by staphylococcus enterotoxicus in the presence of Fe^{59}, I^{131}, P^{32}, and S^{35} was described. The uptakes of I^{131}, P^{32}, and S^{35} by this organism were very low (1.8, 4.4, and 2.5%, respectively); whereas the uptake of Fe^{59} was considerable (31.8%). This finding is important as regards the choice of radioisotopes for labeling staphylococcus enterotoxicus and its toxin (enterotoxin). (auth)

10664 DELETERIOUS INFLUENCE OF ORALLY ADMINISTERED TRITIATED THYMIDINE ON REPRODUCTIVE CAPACITY OF MICE. Richard C. Greulich (Univ. of California, Los Angeles). Radiation Research, 14: 83-95(Jan. 1961).

Tritiated thymidine was administered chronically in drinking water at a concentration of 2 μc/ml to normal adult mice before and during the course of gestation. Under the conditions of the experiment, the approximate oral doses of H^3 to females ranged from 245 to 300 μc over periods of from 24 to 32 days. During their contact with the females, adult male breeders also consumed the labeled thymidine solution in quantities ranging from 8 to 167 μc, over periods of from 1 to 18 days. No information is available to indicate the absolute body burdens which these oral dose levels represent. Delivery of apparently normal litters of young followed the first mating experiment, during which both males and females had received tritiated thymidine. However, in subsequent breeding contacts between the treated males and females, as well as between treated males and normal stock females, there was a rapid decline in reproductive capacity, which was characterized by an increased incidence of stillbirth, fetal resorption, and male sterility. Preliminary histological investigation has confirmed the existence of testicular damage in the treated males at the highest dose levels. A radiation-induced alteration of uterine function is suggested as being responsible for the prolongation of parturition, which was observed in two of the thymidine treated females and which led to the delivery of stillborn litters. The offspring resulting from the initial successful breeding experiment were themselves interbred on attaining sexual maturity. Their reproductive capacity was also markedly reduced, as evidenced by an incidence of stillbirth and neonatal death approximating 70%. (auth)

10665 EFFECTS OF DEUTERIUM OXIDE UPON POLIOVIRUS MULTIPLICATION. Richard I. Carp, David

Kritchevsky, and Hilary Koprowski (Wistar Inst. of Anatomy and Biology, Philadelphia). Virology, 12: 125-7(Sept. 1960).

The effects of deuterium oxide on the multiplication of CHAT, an attenuated type of poliomyelitus virus, was studied in cells of HeLa and of monkey kidney cells in primary cultures. Yields of virus obtained from deuterated cells were consistently higher than those obtained from controls. The incorporation of deuterium oxide in the growth media resulted in an increase in the average plague size of polio virus. (C.H.)

Fallout and Ecology

10666 (AD-243421) A NOTE ON THE TIME OF DURATION OF CLOSE-IN FALLOUT DEPOSITION FROM MEGATON EXPLOSIONS. G. H. Gilbert (Canada. Defence Research Board). Mar. 1960. 10p. (CD-5)

A study was made of the effects of meteorological factors on the time of and the duration of depositions of close-in fall-out. Examples of the rate of build-up of radioactivity observed during fall-out from nuclear-weapons tests are discussed. Estimates are given of the time of deposition, time of peak radioactivity, and duration of fall-out for various wind conditions. (C.H.)

10667 (NYO-9466) DISPOSITION OF NUCLEAR FALLOUT DEBRIS. Annual Report. Arthur R. Schulert, J. Laurence Kulp, Rieta Slakter Hirshman, Elizabeth J. Hodges, Karlin Bartelsen, Homer McFadden, Monty Solazzi, and Eugene Martin (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory. Geochemical Lab.). Oct. 1, 1960. 182p. Contract AT(30-1)-1656.

Data are summarized from a survey on world-wide deposition of nuclear fall-out debris. Data through May 1960 are tabulated and are compared with data accumulated since 1957. The status is reviewed of the analytical work on Sr^{90} determinations in human bones. These data form the basis for prediction of the distribution of Sr^{90} in the human population. Data are included on the content of Sr^{90} and Cs^{137} in milk samples and nonmilk foods from various parts of the world. Analytical methods are included for Sr^{90} assay in bone, foodstuffs, and other environmental media. A list is included of publications from 1955 to 1960. (C.H.)

10668 (AEC-tr-4245) BIOGEOCHEMICAL STUDIES WITH STRONTIUM-90, CESIUM-137 AND OTHERS. Yoshio Hiyama. Translated from Nippon Gakujutsu Shinkokai, 79-93(1960). 39p.

Results obtained in Japan in 1958 and 1959 are reported from a study of the movement and equilibrium of fall-out from nuclear fission experiments through the chain running from soil, the hydrosphere, land and marine plants and animals to foods and eventually to the human body. Results of quantitative geological, biological, and chemical studies will be used to calculate the amount of fall-out that will be accumulated in the human body in the future. Data are included from measurements of radioactivity in samples of air, water, soil, vegetation, milk, tissues, and bones collected from various locations in Japan. Measurements of gross activity and concentrations of Sr^{90} and Cs^{137} were made on a number of the samples. Data are included from a study of the annual variation in the concentration of Sr^{90}, Ru^{106}, Cs^{137}, and Ce^{144} in tea leaves during 1957, 1958, and 1959. (C.H.)

10669 (CEA-tr-A-838) LA TENEUR EN Sr^{90} DU LAIT PENDANT LES ANNÉES 1955 À 1957 (INCLUS). (Content of Sr^{90} in Milk for the Years 1955 to 1957 (Inclusive). E. Knoop and D. Merten. Translated into French from Naturwissenschaften, 45: 194(1958). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 9652.

10670 A COMPARISON OF THE INFLUENCE OF SOFT AND HARD X-RAYS ON THE MANIFESTATION OF POLYHEDRAL DISEASE IN THE SILKWORM. A. E. Karpov (Inst. of Zoology, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 11, 1552-4(1960). (In Ukrainian)

A comparative study was undertaken of the influence of soft and hard x rays (dosage 5000 r) on the activation of the latent nuclear polyhedral virus in the silkworm (Bombyx mori L., breeds US-I and B-II). The incidence of induced polyhedrosis depends on the kind of irradiation, as well as on the hereditary properties and stage of development. In caterpillars, soft x rays induced polyhedrosis approximately twice as frequently as hard rays. Irradiation of pupae caused no activation of the latent virus. (auth)

10671 LONG-TERM ECOLOGICAL STUDY IN THE OAK RIDGE AREA. III. THE ORIBATID MITE FAUNA IN PINE LITTER. D. A. Crossley, Jr. and Kurt K. Bohnsack (Oak Ridge National Lab., Tenn. and San Diego State Coll., Calif.). Ecology, 41: 785-90(Oct. 1960).

From 215 samples of pine forest litter taken in the Oak Ridge area during the summer of 1956, a total of 30,371 arthropods was obtained. Of this number, mites comprised 82.9%, collembolans 12.2%, and other insects 3.6%. Particular attention was directed toward the oribatid mites. The samples were taken from 3 similar areas, each of which was represented by 3 stations. Three samples were taken from each station each week for a period of 8 weeks during July and August. Thus a hierarchic measure of the variation in abundance was obtained for the more abundant oribatid species. Results of analysis of variance tests showed that significant variation occurs both between stations within areas and between the areas, for certain of the abundant oribatid mites. Fager's (1957) trellis diagram method was used to detect significant joint occurrences between species; only a single recurrent group of species was found. Although the 3 study areas had different relative abundances of certain of the more numerous species, it was concluded that the differences between areas represent local variations in a single oribatid fauna, rather than elements of 2 or more faunas. (auth)

10672 THE UPTAKE OF RADIOACTIVE STRONTIUM BY CROPS UNDER FIELD CONDITIONS IN THE UNITED KINGDOM. G. M. Milbourn (Agricultural Research Council, Letcombe, Berks, Eng. and Compton, Berks, Eng.). J. Agr. Sci., 55: 273-82(1960). (A/AC.82/G/L.514)

Field experiments are described in which the absorption of radioactive strontium by rye-grass and lucerne was investigated during 1958 on five soil types which represent a range in exchangeable soil calcium content. Sr^{89} was applied as a spray to both arable land and to established pasture. Absorption was reduced by a factor of up to 4 in rye-grass following plowing to 11 in. compared with leaving the contamination on the soil surface. These results are compared with those obtained in an earlier series of experiments in 1957. The ratio of Sr^{89} to calcium was highest in crops grown on soil low in calcium. The addition of lime reduced absorption of Sr^{89} from the soil only when the exchangeable soil calcium content was relatively low. Some effect was observed in soils containing 7 to 8 meq calcium/100 g, a considerably larger one in a soil containing 2 meq. Only small differences occurred in the ratio of Sr^{89} to calcium between lucerne and rye-grass. This comparison

was not made beyond the first 6 months of growth. Experiments carried out with established pastures on four soil types indicate that Sr^{89} is more readily absorbed from the plant-base than after incorporation with soil. Plowing and reseeding may reduce the ratio of Sr^{89} to calcium in herbage by a factor of up to 4. This effect may be greater on mature swards. The liming of contaminated swards reduces the ratio of Sr^{89} to calcium in herbage by a factor of 2 to 3 regardless of the calcium content of the soil, and liming followed by plowing and reseeding by a factor of 3 to 7. (auth)

10673 OBSERVATIONS ON TWO PRECIPITATIONS OF RADIOACTIVE DUST. Antonio Sellerio, Carmelo Cappadona, and Maria Carmela Romano (Università, Palermo, Italy). Ricerca sci., 30: 1749-59(Nov. 1960). (In Italian)

Observations were made of samples of radioactive sand or dust that fell in Palermo on two windy days, July 4, 1959, and May 4, 1960. The decay of the radioactivity was followed and it was found that the radioactivity was due to nuclear fission products. The first sample had fission products of older origin. The energy of the β particles emitted from the second sample was determined. (auth)

10674 OCCURRENCE OF TECHNICAL ATOMIC AEROSOLS IN THE ATMOSPHERE. J. A. Schedling. Staub (Düsseldorf), 20: 139-44(May 1960). (In German)

After a survey of the possible sources for the occurrence of atomic aerosols, an extensive report is presented for radioactive fall-out which arises as a consequence of nuclear weapon tests in the free atmosphere. An apparatus for automatically collecting samples and for determination of their long life β activity is described. Measurements of the Sr^{90} content and the results of γ spectrometric analysis of these samples are reported (APCA abstract).

Radiation Effects on Living Tissues

10675 (A/AC/82/G/L.405) VLIYANIE IONIZIRUYUSHCHIKH IZLUCHENII NA PLODOVITOST SAMOK NEKOTORYKH VIDOV GRYUZUNOV. (The Effects of Ionizing Radiation on the Fertility of Females of Some Rodent Species.) (Akademiya Nauk S.S.S.R.). 1960. 115p.

Four papers are included; separate abstracts have been prepared for three. (D.E.B.)

10676 (A/AC.82/G/L.405(p.5-47)) VLIYANIE RENTGENOVSKOGO I γ-OBLUCHENII NA ESTRAL 'NYI TSIKL SAMOK MYSHEI. (Effects of X and γ Radiation on Oestrus Cycle in Mice). N. I. Nuzhdin, N. I. Shapiro, O. N. Petrova, and O. N. Kitaeva (Akademiya Nauk S. S. S. R.).

A whole-body, single dose of x radiation disturbs the oestrus cycle in female mice; the disturbance is in direct relation to dosage. Cyclic disturbances in mice exposed to a minimum dose of 50 r appear six weeks after the exposure, and by the third month the cycling stops. With larger doses (100, 200, and 400 r) the latent period is shorter and the oestrus cycle is depressed at the second month. Six months following exposures of 50 to 400 r the oestrus cycle is permanently damaged. Chronic exposure to small doses of γ rays also induces oestrus cycle disturbances. (R.V.J.)

10677 (A/AC.82/G/L.405(p.79-104)) VLIYANIE RENTGENOVSKOGO OBLUCHENIYA NA X VYZHIVAEMOST I PLODOVITOST MORSKIKH SVINOK. (Effects of Radiation on the Survival and Fertility of Guinea Pigs.) N. I. Shapiro, N. I. Nuzhdin, and O. N. Petrova (Akademiya Nauk S. S. S. R.).

The lethal effects of x radiation on male guinea pigs and the effects of x-ray dosage on the fertility of females were studied. Seventy-four 500-g males and 176 485-g females were exposed to 100, 200, 300, 400, 500, 600, 800, 1000, 1500, and 2500 r. For females $y = -3.11092 + 3.16519x$ and for males $y = -0.80582 + 2.45086x$ (y is the percentage of perished animals; x is the logarithm of dose). The female guinea pigs exhibit less sensitivity to the lethal dose than the males. The females suffered no oestrus cycle disturbances 10 to 20 months following whole-body exposure to a single dose of 100 to 500 r. As a matter of fact, the females perished before showing any disturbances in oestrus cycles. However, the exposure reduced the weight of ovaries and the number of follicles in the ovary. The reduction is in direct proportion to dose and is strongly expressed about 10 to 24 months following the exposure. The radiosensitivity of the ovaries of various animals can be expressed as: mouse >> human > rat > guinea pig. (R.V.J.)

10678 (A/AC.82/G/L.405(p.105-15)) RADIOCHUVSTVITEL'NOST YAICHINKOV ZOLOTISTYKH KHOMYAKOV. (Radiosensitivity of Ovaries in Hamsters). O. N. Petrova (Akademiya Nauk S.S.S.R.).

A whole-body, single dose of x radiation (200 to 700 r) induces permanent damage to the oestrus cycle in hamsters. The disturbance of the oestrus cycle is in direct relation to dose and time. Radiation induced diminishing of the number of follicules in the ovary is also in direct relation to dose. A dose of 200 r is the minimum for sterilization 10 months following the exposure; a dosage of 500 r induces total sterilization about 6 to 10 months after the exposure. The radiosensitivity of hamsters is between that of mice and guinea pigs. (R.V.J.)

10679 (AD-237245) PROTECTIVE EFFECTS OF CERTAIN NATURAL FOODS AGAINST WHOLE-BODY IRRADIATION. [Period Covered]: 15 January 1959–14 April 1959. William J. Darby, Frank R. Blood, John G. Coniglio, Carl E. Miller, and James Farrar (Vanderbilt Univ., Nashville. School of Medicine). June 2, 1960. 9p. Project No. 7-84-13-002A. Contract DA-19-129-QM-1307.

Seventy-five male rats, divided into three groups according to diet, were irradiated with 800-r total-body irradiation. All control animals were dead by the 13th day after irradiation; those receiving broccoli were dead by the 19th day; and those on mustard greens by the 27th day. (auth)

10680 (AMRL-459) PROTECTION FROM RADIATION INDUCED LETHALITY BY CHEMICAL MIXTURE AND PARTIAL-BODY SHIELDING. R. I. H. Wang and J. G. Kereiakes (Army Medical Research Lab., Fort Knox, Ky.). Dec. 20, 1960. 13p.

Preradiation administration of a chemical mixture containing 2.5 μm serotonin, 7.5 μm AET, and 30 μm MEA resulted in 79% survival of mice exposed to 1400 r of x irradiation (LD_{100} at 900 r). Partial-body shielding by the use of lead grids was shown to provide no protection to mice exposed to doses above 1200 r. However, the combination of preradiation chemical treatment and partial-body shielding protected 98% of the animals at 1400 r. While only 22% survival was found in the chemically treated mice irradiated at 2000 r, 74% of the mice receiving combined protection remained alive. (auth)

10681 (NP-9857) QUARTERLY PROGRESS REPORT NO. 38. (Chicago. Univ. Air Force Radiation Lab.). Jan. 15, 1961. 128p.

Separate abstracts have been prepared on nine sections of this report. (C.H.)

10682 (NP-9857(p.1-14)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. THE INFLUENCE OF CYSTEINE, 2-MERCAPTOETHYLAMINE AND 5-HYDROXYTRYPTAMINE ON THE RADIATION-INDUCED CHANGES IN ENZYME ACTIVITIES OF THE HEMATOPOIETIC TISSUES AND SMALL INTESTINE OF RATS. Bernard E. Hietbrink, Ann B. Raymund, and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

The reduction of radiation-induced changes in the adenosine triphosphatase activity of the spleens and thymus glands and in the acetylcholinesterase activity of the small intestines of rats was employed as a means of determining the protective effect of chemical agents against injury to these tissues caused by single and repeated doses of ionizing radiations. Injection of serotonin or MEA prior to 200 r on alternate days reduced the increase in adenosine triphosphatase activity of the spleens of rats given up to 600 r, but administration of cysteine failed to alter the effects of x rays in this tissue. These compounds did not significantly protect the thymus glands against the effect of repeated doses of x irradiation. Cysteine prevented the radiation-induced decrease in cholinesterase activity of the small intestine caused by 400 r but serotonin and MEA enhanced the injurious effects produced by repeated doses of x rays. The combinations of cysteine plus serotonin and cysteine plus MEA were effective in reducing the effects of repeated doses (200 r) of radiation at all radiation levels tested. Cysteine plus MEA also reduced the radiation-induced increase in the enzyme activity of the thymus glands in all cases. These combinations were not effective in reducing the decrease in cholinesterase activity caused by repeated exposure to 200 r. Serotonin provided a constant degree of protection to the spleens of animals given single doses of x rays ranging from 100 to 400 r. The combination of cysteine plus serotonin substantially reduced the increase in activity caused by 300 and 400 r of x radiation. These agents reduced the damaging effects of 400 r in the thymus glands but failed to benefit this tissue against injury produced by lower doses. Pretreatment with these compounds also diminished the degree of radiation-induced decrease in the cholinesterase activity of the intestine in all cases tested. Administration of cysteine prior to exposure to 100 r daily or 200 r on alternate days until death did not increase the survival time of the animals. These animals and the control groups had a median survival time of 19 days. Injection of MEA or the combination of cysteine plus MEA before 200 r on alternate days caused slight increases in the total accumulated doses. (auth)

10683 (NP-9857(p.15-23)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. STUDIES ON THE TOXICITY OF RARE EARTH COMPOUNDS AND THEIR INFLUENCE ON RADIATION LETHALITY. David W. Bruce and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

Rare-earth nitrates given intraperitoneally to rats were found to have the following LD_{50} values in mg/kg on the basis of the metal content: Ce^{93}, Dy^{104}, Tm^{104}, and Lu^{125}. All the rare earths with the exception of lutetium, the heaviest metal of the group, are of the same relative toxicity. The approximate LD_{50} values for the rare-earth nitrates given intraperitoneally to mice ranged from 79 to 168 mg/kg on the basis of the metal content of the salts. Included in this study were the nitrates of didymium, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. The results indicate that the compounds are not as toxic to mice as they are to rats. Studies on the mortality of rats given nitrate salts of Er, Eu, Gd, Pr, and Yb with 500 r of whole-body x irradiation demonstrated that the rare earths caused an increase of 27 to 74% in mortality as compared with this dose of x ray alone. Increasing the amount of radiation to 600 and 700 r decreased the additive effect on the basis of the use of mortality alone as the end-point because of the high mortality caused by these doses of radiation. (auth)

10684 (NP-9857(p.24-31)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. III. THE INFLUENCE OF X-IRRADIATION ON THE ENZYME ACTIVITY OF SOME TISSUES OF WEANLING RATS. Esmat A. Ezz and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

A study was undertaken of the injurious effects of various doses of x rays on weanling rats using adenosine triphosphatase assays on spleen and cholinesterase measurements on the intestine to measure the degree of radiation injury. The amount of radiation damage was higher in male than in female weanling rats. This effect was greatest when the animals were exposed to 100 r and gradually disappeared with higher doses. The extent of radiation injury was less in weanlings than in adults, and the rate of reversal of the inhibition was considerably more rapid in weanlings than in adults. (auth)

10685 (NP-9857(p.32-41)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. IV. EFFECT OF OVARIECTOMY AND ESTROGEN THERAPY ON RADIATION INJURY. Esmat Ezz and Kenneth P. DuBois (Chicago. Univ. Air Force Radiation Lab.).

The subcutaneous administration of 1 mg/kg of estradiol every other day for three weeks to adult female rats decreased the amount of change in the adenosine triphosphatase activity of the spleen by 45%. However, this drug treatment after 400 r increased the enzyme change in the spleens of weanlings by 56%. The administration of estradiol had no effect on the amount of injury to the intestine of adult female rats caused by 400 r but it increased the radiation-induced intestinal damage in weanling rats. Ovariectomy of adult female rats caused a slight increase in the susceptibility of the spleen to injury by 300 r of x rays but had no effect on the amount of injury which occurred in the intestine. (auth)

10686 (NP-9857(p.42-59)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. MECHANISM OF THE RADIOPROTECTIVE EFFECT OF SEROTONIN. B. J. Tricou and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Results are reported from studies on the effect of various pharmacologic agents on the radioprotective activity of serotonin in mice, measurements of the tissue oxygen tension in serotonin-treated animals, and the effect of repeated daily administration of serotonin on radiation lethality in animals. (auth)

10687 (NP-9857(p.60-79)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. THE INFLUENCE OF VARIOUS CHEMICAL COMPOUNDS ON RADIATION LETHALITY IN MICE. Vivian Pizak and John Doull (Chicago. Univ. Air Force Radiation Lab.).

Forty compounds were evaluated for protective activity against radiation lethality in mice. After determining the toxicity of the compounds they were administered at two dosage levels 10 to 15 minutes prior to a lethal dose of x

radiation. Protective effects were assessed on the basis of the percentage of 30-day survivors after irradiation and the increase in the median survival time of the treated animals as compared with the controls. One compound, methyl p-nitrobenzoate (EK-1329), when administered at a dose of 100 mg/kg prior to the lethal whole-body exposure, permitted 30-day survival of 10% of the mice. Nine thiophenyl anthraquinone derivatives significantly increased the ST_{50} (median survival time) of x-irradiated mice but did not protect sufficiently to permit 30-day survival of any of the animals. Several fumarate and maleate derivatives and two chelating agents produced a slight increase in the median survival time of the x-irradiated mice. The remaining compounds that were tested did not exhibit significant radioprotective activity. (auth)

10688 (NP-9857(p.80-100)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION LETHALITY IN EXPERIMENTAL ANIMALS. III. STUDIES OF THE PHYSIOLOGICAL FACTORS INVOLVED IN CHEMICAL PROTECTION AGAINST RADIATION LETHALITY IN ANIMALS. H. D. Landahl, A. T. Hasegawa, V. J. Plzak, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

The optimal time of administration to obtain maximal protective effects against radiation lethality in mice has been determined for various chemical compounds. These studies indicated that p-aminopropiophenone, serotonin, epinephrine, hydroxyacetonitrile, and norepinephrine should be given immediately prior (within 4 min) to the irradiation exposure to obtain maximal effects. Mercaptoethylamine and aminoethylisothiuronium are effective in preventing radiation lethality in mice when given as long as 30 min prior to the x-ray exposure. Increasing the environmental pressure to 60 lb of oxygen during the x-ray exposure markedly reduced the radioprotective effect of mercaptoethylamine. However, exposure of the treated animals to this high oxygen pressure treatment prior to the x-ray exposure did not alter the radioprotective effect. The radioprotective effects of mercaptoethylamine can be enhanced in mice by subjecting the animals to a reduced atmospheric pressure (hypoxia) during the x-ray exposure. The oxygenation of solutions of mercaptoethylamine prior to their injection destroys their protective effect when basic and reduces their protective effect if they are acidic during the oxygenation period. Measurements of the tissue oxygen tension in the spleen, kidney, muscle, skin, and liver of mice treated with various radioprotective agents were initiated. The preliminary results of these studies suggest that p-aminopropiophenone and epinephrine cause a reduction in the oxygen tension of the spleen sufficiently to account for the radioprotective effects of these compounds. Mercaptoethylamine and aminoethylisothiuronium did not alter the oxygen content of the spleen of treated animals and hydroxyacetonitrile increased the oxygen content of the spleen when measured at 10 min following the administration of the compound to mice. (auth)

10689 (NP-9857(p.101-15)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. I. CHEMICAL PROTECTION AGAINST CHRONIC RADIATION INJURY IN MICE. J. Doull, V. Plzak, and M. Root (Chicago. Univ. Air Force Radiation Lab.).

The preirradiation administration of mercaptoethylamine (200 mg/kg/day) was not effective in reducing radiation lethality in mice exposed to chronic x irradiation at dosage levels of 40 through 200 r per day. The postirradiation administration of mercaptoethylamine increased the susceptibility of mice to the lethal effects of chronic x-ray exposure at a dosage level of 50 r per day. The daily administration of mercaptoethylamine can be tolerated by mice for at least two months without the production of mortality or marked weight loss. The daily administration of increasing dosage levels of mercaptoethylamine to mice permits the animals to withstand the single administration of at least 400 mg/kg. (auth)

10690 (NP-9857(p.116-26)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. II. INFLUENCE OF DAILY EXPOSURES TO GAMMA RADIATION ON THE HEMATOPOIETIC TISSUES OF RATS. Kenneth P. DuBois and Ann B. Raymund (Chicago. Univ. Air Force Radiation Lab.).

The chronic effects of cobalt γ radiation were studied by exposure of rats to 20 and 40 r per day. Adenosine triphosphatase assays on the spleens and thymus glands were used for quantitative measurement of the amount of radiation injury. Exposure to 20 and 40 r during a 12-hr period each day caused a progressive increase in the adenosine triphosphatase activity of the spleen until a total accumulated dose of about 350 r had been given. Continued exposure resulted in maintenance of the activity, and presumably the amount of injury, at a constant elevated level which was somewhat greater for the 40-r animals than for those receiving 20 r per day. Only a small increase in the adenosine triphosphatase activity of the thymus glands was observed during prolonged exposure of rats to these daily doses of γ radiation. Measurements of the rate of reversal of the injury to the spleen and thymus glands of rats were performed following exposure to total accumulated doses of 200, 400, and 800 r. It was found that nearly complete reversal of the injury occurred within 14 days, which is similar to the rate of reversal of injury from comparable single doses of x rays. (auth)

10691 (TID-6999) EFFECTS OF CRANIAL X-IRRADIATION ON PSYCHOLOGICAL PROCESSES IN RATS. Progress Report for November 15, 1959 to November 15, 1960. W. J. Arnold (Nebraska. Univ., Lincoln). [nd]. 4p. Contract AT(11-1)-249.

Progress is reported in a systematic investigation of the psychological effects of 5000-r brain irradiation in rats. The Pavlovian conditioned reflex was used as a test of brain damage. Data are included on the effects of radiation injuries of the brain on life span in rats. Experimental techniques are described. (C.H.)

10692 (UCRL-9448) STUDIES OF THE GRAFT HOST INTERACTION IN THE MOUSE (thesis). James McRae (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 20, 1960. Contract W-7405-eng-48. 81p.

Some aspects of secondary disease were investigated in sublethally x-irradiated F_1 hybrid mice injected with parental mesenchymal cells. Wasting animals handled their food in a bizarre manner, chewing and dropping large amounts to the bottom of the cage and actually swallowing less than the control mice. The weight loss in these experiments could largely be attributed to the decreased food intake. When parental lymphoid tissue was given, red cell production, as measured by the incorporation of Fe^{59}, was small. However, when parental spleen cells were given, red cell production was considerably greater. There was no evidence for peripheral hemolysis or loss. The anemia can therefore be attributed to a central failure of production of host type red cells, and when adequate hematopoetic cells are transplanted the anemia is controlled. The livers were macroscopically normal, but liver function was abnormal. Sleep time after a standard dose of nembutal/gram

of body weight was greatly prolonged in wasting mice, and fixation of liver glycogen was decreased. These results suggest that liver function is impaired in secondary disease. Reticuloendothelial activity was increased but did not differ from that of mice injected with isologous spleen cells. The significance of this result remains to be determined. (auth)

10693 (USNRDL-TR-474) EFFECT OF REPEATED ROENTGEN AND NEUTRON IRRADIATION ON THE HEMATOPOIETIC SYSTEM. S. J. Baum, A. K. Davis, and E. L. Alpen (Naval Radiological Defense Lab., San Francisco). Oct. 24, 1960. 26p. Contract MR 005.08-1200.

Groups of six mongrel dogs were subjected repeatedly to either 150 rads of x rays or 150 rads of neutrons at 3-month intervals. A third group of six nonirradiated dogs was the control for any possible age or seasonal effects. After each of the four irradiation exposures, various hematological parameters were studied. It was observed that, while the dog normally incorporates nearly all the injected Fe^{59}, a 150-rad dose of either x rays or neutrons reduces iron uptake to 70% of the injected dose. Similarly to what was previously reported for the rat, with each repeated irradiation a reduction below the iron incorporation value obtained in the previous exposure may be observed. The data may again best be described with a simple exponential equation. Although hematocrit values did not change until after the third irradiation, the erythrocyte volume decreased continuously, which further implicates residual radiation effects to the erythropoietic system. The employed radiation dose caused the characteristic decrease in peripheral leukocyte and platelet values, and complete recovery was not observed with repeated exposures. In general, the effects of x irradiation on leukocyte and platelet counts appeared to be greater than those of neutron irradiation. Finally, whereas four out of six x-irradiated dogs died after four replicated exposures, only one neutron-exposed dog did not survive. (auth)

10694 (USNRDL-TR-482) HYPOCALORIC FEEDING AND RADIATION TOLERANCE. H. W. Carroll and R. W. Brauer (Naval Radiological Defense Lab., San Francisco). Nov. 29, 1960. 19p.

Experiments were performed to compare the radiation sensitivity and the dose mortality curves of hypocalorically reared rats and freely fed controls. The radiation resistance of hypocalorically reared rats is significantly reduced when compared to freely fed controls. The LD 50/30 of the rats on the hypocaloric regime in these experiments was 624 ± 24 rad as compared to 709 ± 32 rad for normally fed controls. Food intake and body weight changes showed the usual period of anorexia and body weight losses after irradiation in the rats fed ad libitum, whereas, hypocalorically reared rats displayed no recognizable body weight loss nor anorexic responses to radiation exposure. No apparent sizeable differences were observed with regard to pattern of mortality between the hypocalorically reared rats and rats fed ad libitum. The decreased radiation resistance of the hypocalorically reared rats does not appear to be attributable either to the size of the rats or to the extended life span of these animals. (auth)

10695 (WRU-400) A STUDY OF THE PHYSIOLOGICAL FUNCTION AND HISTOLOGICAL CHANGES OF THYROIDS IRRADIATED WITH RADIOACTIVE IODINE. Progress Report and Proposal for Continued Research October 1, 1959–October 1, 1960. Brown M. Dobyns (Western Reserve Univ., School of Medicine. Cleveland). [nd]. Contract AT(30-1)-1243.

Progress is reported in studies on the physiological and morphological effects of I^{131} radiation on the thyroid. Data are included on the physiological changes produced in human thyroids after the administration of therapeutic doses of radioactive iodine. Serial quantitative chromatograms on the blood of 115 patients were studied. During the first few days the observations essentially reflect unaltered function of the thyroid, but with the passage of time the observations reflect the effects of radiation. The changing patterns of iodinated compounds in the blood, alterations in rate of return of the radioactivity to the thyroid, and the subsequent testing of the functional capacity of the gland permit an analysis of the effects of radiation. Preliminary results are reported from combined acute and chronic experiments in rats on the effects of various doses of I^{131} at various time intervals and with and without thiouracil. Tritiated iodine was used in studies on the effects of I^{131} on the uptake of thymidine by nuclei of thyroid cells. Measurements were also made of the levels of desoxyribonucleic acid in individual cells at intervals of 5 to 90 days after the administration of various doses of I^{131}. (C.H.)

10696 (JPRS-7666(p.42-61)) THE RADIOSENSITIVITY OF NERVE CELLS OF THE RAT CEREBELLUM TO THE EFFECT OF β-RADIATION. A. A. Manina. Translated from Tsitologiya, 2: No. 3, 287-95(1960).

By means of the experimental-morphological investigation of the effect of different doses of radioactive phosphorus on the nervous systems of white rats, it was possible to determine the critical periods in the development of the nerve cells of the cerebellum, at which time the latter are sensitive to β-radiation. Neuroblastic elements at the early stage of development possess the highest sensitivity to β radiation, which exerts a primary pathogenic effect and produces the death of cells several hours after the administration of P^{32}. The period of high radiosensitivity of cells is brief and is not simultaneous for the various cellular elements of the same layer. Differentiated mature nerve cells possess a high degree of resistance to β radiation, which even in high doses does not cause a primary pathological effect. However, reactive phenomena in them can be followed morphologically. They are manifested as a change in the nature of the arrangement of basophilic substance and different degrees of chromatolysis in it, reflecting changes in the nuclein and protein metabolisms in the nerve cells. The pathological effect depends more on the stage of development of the various parts of the central nervous system of the embryo than on the strength of the effect, determined by the dose of the irradiation. Doses of P^{32}, which are almost harmless to the adult organism, cause very severe pathological changes and cerebral lesions in embryos and in the newborn. (auth)

10697 (JPRS-7666(p.83-97)) INVESTIGATION OF THE REACTION OF BONE MARROW CELLS OF ANIMALS TO THE EFFECT OF IONIZING AND ULTRAVIOLET RADIATION BY THE METHODS OF ULTRAVIOLET AND FLUORESCENCE MICROSCOPY. M. P. Bukhman and T. M. Kondrat'eva (Kondrat'yeva). Translated from Tsitologiya, 2: No. 3, 309-17(1960).

Under the influence of the effect of penetrating radiation on the animal organism, definite changes occur in bone marrow cells before any noticeable structural injuries. The absorption of the UV rays is shifted to the direction of the long waves. The least differences between the absorptions by experimental and control cells are observed at wavelengths of 280 to 254 mμ; the greatest differences at a wavelength of 365 mμ. There is a considerable increase in the absorption of ultraviolet rays of this wavelength by

cells of irradiated animals, whereas cells of control animals practically do not absorb them. There is an increase in the size of the cells. There is also an increase in the variability of their dimensions, which is best expressed in the immature forms of the myeloid series and least in the segmented neutrophils and erythroblasts. (auth)

10698 EFFECTS OF TOTAL BODY X-IRRADIATION ON THE ALDEHYDE-FUCHSIN-POSITIVE MATERIAL IN THE NEUROHYPOPHYSIS AND IN THE SUBCOMMISSURAL ORGAN OF THE RAT. S. Talanti and V. Viljanen (Veterinary Coll., Helsinki). Acta Pathol. Microbiol. Scand., 50: 278-82(1960). (In English)

Effects of total-body x irradiation on the amount of the aldehyde-fuchsin-positive neurosecretory material in the neurohypophysis and on the amount of the aldehyde-fuchsin-positive secretion in the subcommissural organ in rats that died after irradiation were investigated. It was observed that the neurosecretory material in the neurohypophysis strongly decreased in amount; whereas the amount of the secretion in the subcommissural organ did not change. (auth)

10699 SKIN AND SUBCUTANEOUS REACTIONS INDUCED BY SUPERVOLTAGE IRRADIATION. Leonard M. Liegner and Normand J. Michaud (St. Luke's Hospital, New York). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 533-49(Mar. 1961).

Supervoltage irradiation is skin sparing if certain conditions are met. Not all high-energy γ ray units conform to supervoltage design and may be better designated as the orthovoltage type, which can induce skin reactions similar to those in 200-kv therapy. Significant skin and subcutaneous reactions are induced by supervoltage irradiation even if optimal conditions prevail, the anatomic skin site perhaps being the most important factor, other things being equal. Supervoltage radiation-induced skin reactions may not follow the sequence of events described for lower voltage radiation. Erythema frequently does not occur or, if present, it merges imperceptibly with a tanning reaction. Measures that can be taken to limit the incidence and intensity of supervoltage-induced skin reactions are derived from knowledge and manipulation of a number of factors which are listed. (C.H.)

10700 ABDOMINAL IRRADIATION AND THE THYMUS OF THE ADULT RAT: THE RELATIVE IMPORTANCE OF THE ADRENAL GLANDS AND OF SCATTERED RADIATION. M. J. Corp, A. W. Law, and R. H. Mole (Medical Research Council, Harwell, Berks, Eng.). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 550-8(Mar. 1961).

The degree of damage to the thymus caused by direct irradiation with 25 to 100 r was not altered by a fifty-fold change in dose rate. It was not possible to confirm the often-cited finding that the effect of abdominal irradiation on the thymus is due to stimulation of the adrenal gland. Abdominal irradiation of starved adult rats with 2000 or 5000 r caused a 25 to 40% reduction in thymic DNA-P and in thymic weight 48 hr later. However, adrenalectomy scarcely modified the degree of change which could be almost wholly accounted for by the scattered radiation which is presumed to reach the thymus. Physical and biologic measurements of the scattered dose were in agreement. In control animals adrenalectomy led to an increase in the weight of the thymus and to a decrease in starvation. In view of the effect of abdominal irradiation on food intake and the effect of food intake on the thymus, evidence from starved animals is considered to be more reliable than evidence from animals with free access to food when investigating the possible existence of abscopal effects of abdominal irradiation on the thymus. (auth)

10701 CHEMICAL ANTIDOTES FOR RADIATION INJURY. John Doull (Univ. of Chicago). Arch. Environmental Health, 2: 284-92(Mar. 1961).

The development of antidotes to radiation toxicity is hampered by a lack of understanding of mechanisms by which radiation produces its toxic effects. Antidodes are defined as substances which counteract the effect of toxic agents either through chemical inactivation or by antagonizing the physiological effects of the poison. Radioprotective agents can be considered as antidotes against radiation injury. Most of the currently available chemical antidotes against radiation injury are of the prophylactic type and are not effective unless given prior to the time of radiation exposure. The therapy of radiation injuries depends at present on the symptomatic or postirradiation treatment of specific aspects of the radiation syndrome. A review is included of the effects of anoxia, cyanide, various chemicals which produce methemoglobinemia, various aniline and acetamide derivatives, certain biological amines, sulfhydryl or thiol derivatives, and other chemicals against radiation injuries in mammals. Possible reaction mechanisms are discussed. 50 references. (C.H.)

10702 ASCORBIC ACID METABOLISM IN THE WALLS OF THE AORTA IN DEVELOPMENT OF RADIATION INJURY. L. I. Polikarpova. Biochemistry (U.S.S.R.) (English Translation), 25: 356-8(Nov.-Dec. 1960).

Acute radiation sickness causes changes in ascorbic acid metabolism in aorta walls in animals which synthesize ascorbic acid (rabbits) and in those which do not (guinea pigs). In guinea pigs the content of ascorbic acid decreases 3 to 5 days after irradiation with a sharp increase in the amount of dehydroascorbic acid on the third day; in rabbits the content of ascorbic acid increases on the first day with further fall to normal in relation to the unchanged content of dehydroascorbic acid. The ratio of the amount of dehydroascorbic acid to the amount of ascorbic acid, an indication of the direction of the oxidation-reduction processes in the organism, sharply increased in guinea pigs 3 to 5 days after irradiation, and in rabbits was unchanged. In guinea pigs, the development of radiation sickness led to a considerable deficit of ascorbic acid in the aorta walls, and in rabbits this was not found. (auth)

10703 THE EFFECT OF IONIZING RADIATION ON THE PHOSPHOLIPID METABOLISM IN THE LIVER. A. S. Kainova. Biochemistry (U.S.S.R.)(English Translation), 25: 415-18(Nov.-Dec. 1960).

The total phospholipid content in rat liver does not change during the first day following irradiation by a 1000 r of gamma rays. In rabbits, on the other hand, the liver phospholipids immediately drop 25% subsequent to irradiation of not more than 5000 r. In rat liver, the lecithin fraction of the phospholipids increases 33.7% within 24 hours following irradiation, the sphingomyelin fraction increasing under the same conditions 41.6%, while the cephalin fraction decreases by 56.6%. In rabbits, the lecithin fraction of the liver phospholipids rises 13.4% immediately following irradiation by 5000 r, the sphingomyelin fraction rising 66.5%, while the cephalin fraction drops 34.7%. The general intensity of the phospholipid metabolism in rat liver increases within 24 hours following irradiation with a 1000 r dose. Within two and four hours the relative specific radioactivity of phospholipids increases 100%, within six hours, it increases 137%, and within 24 hours, 42%. The incorporation of labeled phosphate into the liver sphingomyelins increases particularly in the 24 hours following irradiation; the relative specific radioactivity of this fraction is 262.5% above the control. (auth)

10704 ESTIMATION OF MORTALITY INTENSITIES IN ANIMAL EXPERIMENTS. A. W. Kimball (Oak Ridge National Lab., Tenn.). Biometrics, 16: 505-21(Dec. 1960).

The estimation of mortality intensity, also known as age-specific death rate, instantaneous death rate, and force of mortality, from small samples presents serious obstacles. Most of the work on this problem has been published in only the last 10 or 15 years, and has dealt primarily with studies of human populations. Standard actuarial procedures suitable for large samples have proved inadequate for relatively small studies on groups of patients suffering from cancer, heart disease, and other major causes of death. Unlike human studies in which patients are lost from observation and enter observation at different ages, experiments with animals can be controlled with respect to these and many other variables. Several estimation procedures are discussed in terms of their applicability to controlled animal experiments, and the methods are illustrated with data from a radiation experiment with mice. Particular emphasis is placed on the construction of Gompertz plots that are important in evaluating theories of radiation injury and damage. It is found that the applicability of the various procedures depends in part on the type of data available and in part on what assumptions may be admissible. (auth)

10705 EXISTENCE OF SEVERAL TYPES OF LATENT DAMAGE IN IRRADIATED MYOSIN MOLECULES. L. Kh. Eidus and E. (Ye.) E. Ganassi (Inst. of Biological Physics, Academy of Sciences, Moscow). Biophysics (U.S.S.R.) (English Translation), 5: No. 3, 384-9(1960).

It is shown that on anaerobic irradiation two different types of latent damage are formed in myosin molecules. Heat or oxygen acting on the anaerobically irradiated myosin cause additional inactivation. Each of these factors acts only on one of the two types of latent damage and does not act on the other, therefore, with simultaneous application of heat and oxygen the postradiation effect is summated. Oxygen present in the medium during irradiation of myosin does not take part in the formation of latent damage. (auth)

10706 FORMATION OF STABLE ORGANIC PEROXIDES IN THE LIVING BODY AS A RESULT OF IONIZING RADIATION. I. K. Kolomiitseva (Inst. of Biological Physics, Academy of Sciences, Moscow). Biophysics (U.S.S.R.) (English Translation), 5: No. 3, 389-96(1960).

The aerobic method of Hartmann and Glavind as modified by Philpot and Horgan and the author's modification of the anaerobic method were applied to determine the peroxides in auto-oxidized lipids. It is shown that the value of the ratio of the aerobically determined peroxides and the anaerobic values differs for different peroxides and characterizes the reactivity of the peroxide. The lowest value of the ratio taken as 1 was obtained for succinic acid peroxide; the greatest value (4.9) was obtained for the peroxides of auto-oxidized cholesterol. Determination of the peroxides in irradiated n-butanol showed that with the aerobic indophenol method an increase in the amount of peroxides is detected after irradiation with a dose above 1000 r. The anaerobic indophenol method was used to determine the peroxides in intact carcasses of rats weighing 110 to 150 g and in the carcass without the skin of young rats weighing 25 to 30 g. It is shown that the peroxide content in the carcasses immediately after irradiation with a dose of 1000 r does not increase. In the liver, testes, intestines, brain, and muscles the peroxide content is very low and is at the threshold of the sensitivity of the method (0.00 to 0.12 μM peroxide per g tissue). The blood peroxides of rats were determined both in aerobic (0.12 ± 0.07 μM per ml blood) and anaerobic (0.03 μM peroxide per ml blood) conditions. The value of the ratio of the aerobically determined peroxides to the anaerobic ones for blood was 4. This indicates the low reactivity of the blood peroxides. The peroxide content in the skin of adult rats was much greater (0.94 ± 0.24 μM peroxide per g skin) than in the skin of young rats (0.15 ± 0.07 μM peroxide per g skin). The value of the ratio of the aerobically determined peroxides to the anaerobic value for the skin of adult rats was 2.3 which is suggestive of the more reactive nature of the skin peroxides. The amount of peroxides determined in the rat organs immediately after irradiation with 1000 r did not exceed the peroxide content in the organs of the unirradiated animals. (auth)

10707 EFFECT OF IONIZING RADIATION ON PROTEIN METABOLISM IN NUCLEI, MITOCHONDRIA AND ERGASTOPLASM OF THE PLANT ORGANISM. N. B. Strazhevskaya (Strazhevskaia) (Inst. of Biological Physics, Academy of Sciences, Moscow). Biophysics (U.S.S.R) (English Translation), 5: No. 3, 397-406(1960).

A modified method of isolation of nuclei was applied to wheat seedlings. Forty-eight hours after irradiation with Co^{60} γ rays at a dose of 10,000 r, incorporation of S^{35} methionine into the total proteins of the stems was not disturbed. At the same time incorporation of S^{35} methionine into the proteins of the cell fractions was changed; the incorporation of S^{35} methionine into the protein of the mitochondrial fraction was somewhat increased, with almost no change in this respect for the nuclear and ergastoplasm fractions. Gamma radiation at a dose of 10,000 r led to depression of growth of the seedling by 23.7% and to a decrease in the number of nuclei by half. In the irradiated cell there was a distinct increase in the protein content in the mitochondrial fraction on calculation per cell. (auth)

10708 EXACT DOSE X-IRRADIATION OF VARIOUS REGIONS OF THE HEAD AND VISUAL SENSATIONS—X-RAY LOCATION METHOD OF STUDY OF THE REACTIVITY OF THE CENTRAL NERVOUS SYSTEM. G. K. Gurtovoi and E. O. Burdianskaya (Ye. O. Burdianskaia) (Inst. of Biological Physics, Academy of Sciences, Moscow and Helmholz State Research Inst. for Diseases of the Eye, Moscow). Biophysics (U.S.S.R.) (English Translation), 5: No. 3, 406-14(1960).

The primary substrate excited by threshold doses of x radiation of the normal human eye causes perception of a light flash in the retinal region. The threshold dose for the retina is about 1 mr; the threshold absorbed dose is about 1 mrad. Persons with a removed eyeball, on irradiation of the operated region with a frontal x-ray beam, perceive a flash of light at definite doses of radiation. Six persons taking part in an experiment saw a flash at doses of 17 to 150 mr (different observers saw flash at different doses) and did not see flash at doses of 5 to 90 mr. The cause of x-ray phosphene on frontal irradiation of the region of the removed eye with threshold doses is neither the reactivity of the optic nerve stump, the reactivity of the parts of the brain irradiated, nor the sensitivity of the skin receptors. In the cases considered, the cause of x-ray phosphene was irradiation of the retina of the normal eye by scattered x rays. The averaged coefficient of scatter was about 2%. On irradiation of the occiptal regions of the brain in subjects with normal eyes at a dose of about 150 mr, one subject perceived a flash of light. In this case, the absorbed dose for the occipital regions of the brain was about 40 mrad. The reason for this phenomenon must be explored. Stimulation of the cerebral formations (after atrophic changes in the visual tract and cortex) by x radia-

tion with a dose of up to 3 r, did not cause visual sensations. With the disposition of the beam, the absorbed dose for the chiasma was about 1 rad and for the occipital regions about 0.2 rad. In the study of threshold visual sensation and their causes on x irradiation of various regions of the head, it is important to apply defined doses of radiation. Scatter of the x rays in the head must be taken into consideration. (auth)

10709 EFFECT OF γ-RAYS AND NEUTRONS ON DRIED SEEDS OF AGRICULTURAL PLANTS. S. A. Valeva (Inst. of Biological Physics, Academy of Sciences, Moscow). Biophysics (U.S.S.R.) (English Translation). 5: No. 3, 415-20(1960).

The difference in radiosensitivity of self-pollinated lines of maize and their hybrid is due not only to the variable powers of regeneration of their tissues but also to the variable degree of susceptibility to damage of the cell nuclei. The difference in sensitivity to irradiation with neutrons of varieties of the same crop with a uniform number of chromosomes of uniform size and shape suggests that in the radioresistant variety there is a certain defense mechanism against the effect of radiations both with low and high specific ionization density. (auth)

10710 INDUCTION OF MAMMOTROPIC PITUITARY TUMORS BY X-RAYS IN RATS AND MICE: THE ROLE OF MAMMOTROPES IN DEVELOPMENT OF MAMMARY TUMORS. Kenjiro Yokoro, Jacob Furth, and Nechama Haran-Ghera (Roswell Park Memorial Inst., Buffalo and Children's Cancer Research Foundation, Boston). Cancer Research, 21: 178-86(Feb. 1961).

Irradiation of the head and neck with 800 r induced pituitary tumors in 20 of 27 female W/Fu rats. Three of these primary tumors were transplanted. The anatomic findings in the tumor-bearing rats indicated that these were mammosomatotropic. In addition, three mammary tumors, one osteogenic sarcoma, and one sebaceous gland carcinoma occurred in the irradiated area and none elsewhere. Mammotropic hormone(s) greatly enhanced the induction of mammary tumors by ionizing radiation. Two mammary tumors occurred in 22 rats given, whole-body, 200 or 400 r x rays alone and thirteen in seventeen irradiated rats that also received a mammotropic tumor graft 2 weeks earlier. In the former group the two tumors were benign; in the latter, benign and malignant tumors occurred in about equal number. Mammotropic graft alone failed to produce tumors in nine rats. In mice, doses larger than 550 r administered over head and neck failed to increase the induction rate of pituitary tumors, whereas oophorectomy with adrenalectomy markedly reduced and estrogen treatment appeared to enhance the pituitary tumor formation. Head and neck x irradiation produced thyrotropic pituitary and thyroid tumors in female LA mice in larger numbers than hitherto observed in normal and total-body x-rayed mice of this strain. Radiation-induced pituitary tumors caused mammosomatotropic effects similar to those observed in animals bearing estrogen-induced or spontaneous pituitary tumors. Attention is called to the puzzling phenomenon that in animals bearing such tumors both thymus and adrenals are enlarged, and data suggest that these tumor cells may also secrete some corticotropin (AtH). (auth)

10711 FREQUENCY OF THYMIC LYMPHOSARCOMAS IN THE DESCENDANTS OF RF MICE IRRADIATED BEFORE MATING. Charles Gosse, Carmen Bernard, Claude Paoletti, and Michel Boiron (Inst. Gustave-Roussy, Villejuif, France). Compt. rend., 251: 2254-6(Nov. 14, 1960). (In French)

Female mice of the RF strain, aged from 70 to 80 days, were exposed to 175 ± 5 r whole-body x radiation. As soon as possible after the irradiation each animal was mated with a nonirradiated brother. Only one litter of six animals was produced because of the radioinduced decrease in fecundity. In this litter of six animals four developed thymic lymphosarcoma, which appeared on an average of 12 months after birth. The irradiated mother showed no tumor. Of the seventeen animals of the second generation which reached adulthood, nine died of thymic lymphosarcoma. The lymphosarcoma observed are characterized macroscopically by a large mediastinal tumor. Hypotheses explaining these data are given. (J.S.R.)

10712 PARTIAL TRANSFORMATION OF OXYHEMOGLOBIN INTO METHEMOGLOBIN IN THE BLOOD OF THE RAT EXPOSED TO X RADIATION. Jean Loiseleur and Michelle Petit. Compt. rend., 251: 2800-1(Dec. 5, 1960). (In French)

After the administration in toto of x radiation, the blood of the rat has a noticeable amount of methemoglobin. This amount of methemoglobin is directly proportional to the dose administered. (tr-auth)

10713 RELATIVE BIOLOGICAL EFFICIENCY OF 157-MEV PROTONS. Paul Bonet-Maury, Aliette Deysine, Marcel Frilley, and Claude Stefan (Institut du Radium, Paris). Compt. rend., 251: 3087-9(Dec. 19, 1960). (In French)

Mice were exposed to a beam of 157-Mev protons, and the dose-mortality curve was determined. For the lethal effect on mice irradiated in toto, the biological efficiency of the protons, relative to 20-kv x rays, is 0.77 ± 0.1. (tr-auth)

10714 ACCUMULATION OF METHEMOGLOBIN IN THE SPLEEN OF RATS EXPOSED TO THE ACTION OF X RAYS. Jean Loiseleur and Michelle Petit (Institut Pasteur, Paris). Compt. rend., 251: 3090(Dec. 19, 1960). (In French)

Methemoglobin, which appears in the blood of rats after irradiation, is accumulated at the same rate in the spleen. (tr-auth)

10715 VARIATION OF THE AMOUNT OF 17-KETOSTEROIDS IN IRRADIATED SUBJECTS. RESULTS OF MEASUREMENTS MADE DURING AN INQUIRY ON THE ELECTRORADIOLOGICAL SERVICES OF PARIS HOSPITALS. A. Dognon, R. Dutheil, and H. Guerin. Compt. rend. soc. biol., 154: 1351-3(1960). (In French)

In a study of technicians exposed professionally to radiation in Paris hospitals, asthenia was often found. To determine causes for this fatigue, blood counts and determinations of 17-ketosteroids were made. The results are tabulated and shown graphically as a function of the dose received in mr. The amount of urinary 17-ketosteroids appears to be an increasing function of the weekly radiation doses. (J.S.R.)

10716 HISTAMINE, 5-HYDROXYTRYPTAMINE, AND PROTECTION OF THE PILOSE SYSTEM OF THE SMALL MOUSE IRRADIATED IN TOTO. D. V. Radivojevic, M. L. Beaumariage, and Z. M. Bacq (Institut des Sciences Nucleaires Boris Kidric, Belgrade and Université, Liège). Compt. rend. soc. biol., 154: 1489-93(1960). (In French)

A study was made to define the radioprotective action of histamine, 5-hydroxytryptamine, and tryptamine. These three amines offer an efficient protection against epilation by x radiation. This protective property is inhibited by its pharmacological antagonistics. In the system considered, the most favorable mechanism action is anoxia. The experimental conditions used did not permit the exclusion of other action mechanisms in the case of 5-hydroxytryptamine and tryptamine. (tr-auth)

10717 CYSTAMINE AND EPILATION OF SMALL MICE BY X RAYS. D. V. Radivojevic. M. L. Beaumariage, and Z. M. Bacq (Institut des Sciences Nucleaires Boris Kidric, Belgrade and Université, Liège). Compt. rend. soc. biol., 154: 1529-32(1960). (In French)

Cystamine (375 to 750 μg injected subcutaneously or intraperitoneally) inhibits the epilation of small mice irradiated in toto with a dose of 550 r of x rays. By decreasing the dose injected under the skin, the general protection is suppressed without the appearance of a local protection. The protective effect of cystamine is not the result of the release of cutaneous histamine. Anoxia can play an important role in this particular case of radioprotection. (tr-auth)

10718 HISTAMINE CONCENTRATION OF THE SKIN OF THE ADULT MOUSE EXPOSED TO X RADIATION. Marie-Louise Beaumariage (Université, Liège). Compt. rend. soc. biol., 154: 1533-5(1960). (In French)

The modification of cutaneous histamine under the effect of x radiation was studied in the adult mouse. Irradiation by a lethal dose does not decrease the histamine concentration in the skin of the adult mouse. In the female, a slight augmentation from the 48th hr after x irradiation was observed. (tr-auth)

10719 GENETIC VARIATION IN OIL AND PROTEIN CONTENT OF SOYBEANS INDUCED BY SEED IRRADIATION. J. H. Williams and D. G. Hanway (Univ. of Nebraska, Lincoln). Crop Sci., 1: No. 1, 34-6(Jan.-Feb. 1961).

Variation in oil and protein content of progenies of R_2 generation and control plants of Adams and Hawkeye soybean varieties was studied to determine effects of irradiation of seeds with thermal neutrons and x rays. Significant amounts of variability existed in all populations derived from irradiation. The only instance of significant variability in control populations was protein percentage in Hawkeye. Estimates of genetic variance and heritabilities were several times greater in the irradiated than in the control populations. Heritabilities were similar to those reported for agronomic characters studied in the same populations and to those reported in the literature for F_2 segregating populations. Sterility was found to be a factor in increasing the genetic variance in the irradiation treatments. However, highly significant increases in genetic variance were obtained in the irradiation treatments as compared to the controls after the effect of observed sterility was eliminated. (auth)

10720 COMPARATIVE EFFECTS OF ELEVATED TEMPERATURE AND 1000 r X-RAYS ON THE SEMINAL EPITHELIUM OF THE MOUSE. Bernard R. Nebel and Carol J. Murphy (Argonne National Lab., Ill.). Cytologia (Tokyo), 25: 244-55(June 1960). (In English)

C57 black male mice about 100 days of age were exposed to elevated temperature of 35°C and 70% humidity in four exposure periods totaling 61 hr distributed over 4 days. Animals were sacrificed at 3, 5, 7, and 10 days after the end of the heat treatment. Results of the heat treatment were compared with those following 1000 r x irradiation. The damage inflicted on the mouse testis by this heat treatment differed fundamentally from that induced by 1000-r acute localized x irradiation. Comparison at 10 days after treatment was especially revealing. Elevated temperature induced the formation of giant cells, originating either from karyokinesis without cytokinesis or from agglomeration. The latter condition was most predominant when spermatozoal heads with indistinct tails were involved. No giant cells were seen after x irradiation. Spermatogonia survived the heat treatment so that after 10 days recovery was in full swing. X rays killed spermatogonia with the exception of occasional type A cells. Recovery had not started after 10 days. Late spermatocytes became pycnotic as a result of heat treatment. Of these, some regressed and a few underwent restitution or C-division. Normal spermatids were not formed. Late spermatocytes were blocked by 1000-r x irradiation. The block was so persistent and so severe that 76% of the tubular cross sections seen at 10 days contained some form of restituted or regressed spermatocytes. Ten days after heat treatment no restituted or regressed spermatocytes were seen. This may be related to the fact that heat seems to be less damaging than x rays to the emptying mechanism of tubules. Spermatids appear equally damaged by heat and by x rays. Spermatozoal heads are more common at 10 days after x irradiation than after heat treatment. This may result from the lesser effect of heat on the emptying mechanism as well as from a qualitative difference in the damage inflicted. (auth)

10721 PRIMARY RADIATION DAMAGE AND ITS REPAIR IN QUIESCENT SEEDS WITH A VARIABLE WATER CONTENT. N. A. Poryadkova (Inst. of Biology, Ural Branch of the Academy of Sciences, USSR). Doklady Akad. Nauk, S.S.S.R. 134, 706-9(Sept. 21, 1960). (In Russian)

Pea seeds of the type Kapital with a water content of 4.8, 6.9, 10.2, 16.8, and 24.4% were given a dose of 15,000 r Co^{60} γ radiation. The percent germinations at 10 days, the amount of growth, the percent of abnormal anaphases, and the percent of cells with fragmentation indicated that the radiosensitivity decreases sharply with an increase in water content from 4 to 20%. A statistical analysis of the cytological data showed that the number of damaged cells was not decreased by the increase in water content. The over-all damage to the cell was less with higher water content due to faster recombination of free radicals, and hence, the repair of cell damage could be effected more rapidly in seeds with a higher water content than was possible in seeds with a lower water content. (TTT)

10722 THE EFFECTS OF NITRIC OXIDE ON RADIATION DAMAGE IN DROSOPHILA VIRILIS AND DROSOPHILA MELANOGASTER. Ann Schlesselman Capps (Univ. of Texas, Austin). Genetics, 46: 123-7(Feb. 1961).

Nitric oxide present during irradiation at a concentration of 3% in helium enhanced genetic damage resulting from 1000 r of x rays. Damage was measured by the production of dominant lethals in Drosophila virilis and sex-linked recessive lethals in Drosophila melanogaster. Under similar conditions 3% oxygen in helium showed no effect on the production of dominant lethals by x rays. Nitric oxide had the additional effect, independent of irradiation, of delaying development of germ cells in Drosophila virilis. (auth)

10723 THE RELATIVELY HIGH FREQUENCY OF WHOLE-BODY MUTATIONS COMPARED WITH FRACTIONALS INDUCED BY X-RAYS IN DROSOPHILA SPERM. Edgar Altenburg, and Luolin S. Browning (Rice Univ., Houston, Tex.). Genetics, 46: 203-11(Feb. 1961).

Among the visible mutations of postmeiotic origin in the sperm cells of Drosophila treated with x rays, 93% appeared to be whole-body, the remaining 7% being fractionals. Among the mutations detected in a chemically treated series and those of postmeiotic spontaneous origin, the percentage of fractionals was relatively high. The high proportion of whole-body mutations in the x-ray-treated series could be accounted for on the theory of Muller, Carlson, and Schalet that radiation may break the bonds of both bases of a nucleotide pair, thereby allowing their rotational

substitution with resultant whole-body mutation. In all three series, the mutant tissue of the fractionals as a rule seemed to involve half of the body, so far as could be determined upon external examination of the fractionals. This half-body amount of mutant tissue indicates that these fractionals arise not as delayed effects followed by errors in replication at the first or later divisions of the fertilized egg (events which would lead to one-fourth or less mutant tissue), but rather that the fractionals in question arise as permanent changes in an already existing DNA molecule, these observations thus supporting the recent conclusions of Muller and his coworkers as to the usual nature of the mutational event. However, some of the mutants may possibly have been one-fourth mosaics. If they were, they would indicate that mutations might sometimes be due to an error in the replication of the gene. (auth)

10724 SKIN AGING AND HAIR GRAYING IN HIROSHIMA. J. W. Hollingsworth (Atomic Bomb Casualty Commission, Hiroshima-Nagasaki, Japan), Goro Ishii, R. A. Conard. Geriatrics, 16: 27-36(Jan. 1961).

Estimation of age by appearance, skin elasticity and looseness, and hair graying were studied in the irradiated and nonirradiated population of Hiroshima. No differences in these several measurements were detected between the radiation-exposed and nonexposed components of the sample. The study provided no support for the concept of a general, nonspecific aging acceleration, exemplified by aging of skin and hair, as a late radiation sequela. (auth)

10725 RADIATION: A CHEMICAL. Sydney F. Thomas (Palo Alto Medical Research Foundation and Palo Alto Medical Clinic, Palo Alto, Calif.). J. Am. Med. Assoc., 175: 783-6(Mar. 4, 1961).

The mechanisms by which ionizing radiation ultimately produces a clinical result are very complicated, but a study of the process of polymerization offers a suitable approach. Polymerization can be initiated by very low doses of ionizing radiation. The random events occurring within chemicals, within cells, or within tissues after irradiation are the results of effects produced by the energy exchange at the randomly spaced sensitive areas, and the results can be both degradation and synthesis of polymeric matrices. This concept is proposed as an integrating complement to the chemical and target theories of radiation effects. It should also afford a logical basis for the methodical investigation of the place of chemicals in combination with irradiation in the treatment of tumors. (auth)

10726 AN ATTEMPT TO QUANTIFY SOME CLINICAL CRITERIA OF AGING. Robert A. Conard (Brookhaven National Lab., Upton, N. Y.). J. Gerontol., 15: 358-63(Oct. 1960). (BNL-4835)

In order to study possible premature aging effects of radiation in the people of Rongelap in the Marshall Islands, a series of measurable criteria generally associated with aging were recorded during the 1959 annual medical survey (5-year postexposure) on 42 people who had been exposed to radiation and 84 unexposed Marshallese. The criteria were chosen on the basis of ease of assessment under field conditions considering time limitation and language barrier. Some criteria were assessed on observation by scoring on a 0 through 4+ and percentage basis (senile skin changes, graying of hair, baldness, arcus senilis, peripheral arteriosclerosis, retinal arteriosclerosis). The other criteria were measured directly and also expressed on a percentage basis (skin looseness, skin elasticity, accommodation of the eyes, visual acuity, hearing by audiometry, blood pressure, neuromuscular function, and hand strength). A skin caliper used for measuring skin looseness and elasticity was described. Since no differences were readily apparent between the exposed and unexposed people, the data were pooled and presented at this time to describe the methodology, trend of criteria changes with age, and attempt to assess biological age. Curves of the plotted data drawn by eye showed varying degrees of age-associated change with different criteria. The measured criteria were generally best correlated with age, particularly accommodation of the eyes, visual acuity, skin elasticity, and hand strength, although some of the observational criteria, such as arcus senilis and graying of the hair, seemed also to be fairly well correlated. A plot of the average percentage scores for individuals by age (biological age score) showed generally increasing scores with ages and less scatter than was noted with individual criteria. It is hoped that this approach may prove helpful in assessing aging in human beings and may offer a clue to possible radiation-induced aging. (auth)

10727 THE ORINS LINEAR SCANNER IN DIAGNOSIS AND TREATMENT OF THYROID CARCINOMA WITH IODINE^{131}. Felix J. Pircher, Beecher W. Sitterson, and Gould A. Andrews (Oak Ridge Inst. of Nuclear Studies, Tenn.). J. Nuclear Med., 1: 251-61(Oct. 1960).

The linear scanner has demonstrated usefulness in the diagnosis and treatment of thyroid carcinoma with I^{131}. It may fill a gap that exists in nuclear instrumentation between the conventional methods of scanning and uptake measurements on the one hand, and whole-body counting, on the other. It profiles the activity within the patient, it scans the whole body in ten minutes, and it offers quantitative information. The accuracy of this quantitative information cannot be defined on the basis of the little evidence presented here. It is probable that the method can be made quantitative, however, and aid in further development of dosimetry of internal radiation. (auth)

10728 THE USE OF THE COUNTING RATE PROFILE IN RADIOISOTOPE SCANNING TECHNIQUES. William J. MacIntyre, Godofredo Gomez Crespo, and James H. Christie (Highland View Hospital, Cleveland). J. Nuclear Med., 1: 262-72(Oct. 1960).

Optimum results were obtained by using predotscan survey profiles for accurate setting of the cut-offs at optimum levels and utilizing both the conventional dotscan and serial profiles for interpretation of radioisotope scans. Although the area scan is useful for the general organ outline, the serial profiles recorded at the time of the dotscan allow a more accurate statistical analysis of any given area for differentiation of deviation from homogeneous distribution. Since the multiple juxtaposed profiles contain all the information in a convenient visual form, it is possible that this technique may supplant present methods. (auth)

10729 EFFECT OF X-IRRADIATION AND NITROGEN MUSTARD ON IRON INCORPORATION IN RAT ERYTHROCYTES. Ali R. Uzel, Esther-Mary Farrington, and Shields Warren (New England Deaconess Hospital, Boston). Lab. Invest., 10: 194-204(Jan.-Feb. 1961).

Groups of Deaconess-Slonaker rats were subjected to various doses of x irradiation and nitrogen mustard and injected with Fe^{59} as a tracer. After total-body irradiation of varying doses, the per cent uptake of Fe^{59} in peripheral erythrocytes was reduced, and the time was prolonged. Recovery was well along by the tenth day. Both depression and recovery were related to dose. Localized irradiation produced erythroid cell depression similar in degree and pattern to that following total-body irradiation. After administration of nitrogen mustard, changes in Fe^{59} uptake similar to those found after total-body irradiation were observed in

the peripheral blood. Iron not utilized by bone marrow is deposited in the liver, and, possibly, elsewhere. At present, the nature of the mechanism that governs the delay of erythrocyte appearance in peripheral blood and of that responsible for incomplete or delayed recovery remains obscure. (auth)

10730 THE EFFECT OF MASSIVE DOSES OF BETATRON RADIATION ON THE BLOOD AND HEMATOPOIETIC ORGANS. T. I. Gorshenina, E. D. Goldberg, and O. S. Golosov (Tomsk Medical Inst., USSR). Med. Radiol., 5: No. 11, 14-20(Nov. 1960). (In Russian)

A description is presented of the morphology of blood and bone marrow cells of animals subjected to massive doses of irradiation from a betatron (9000 to 16,000 r). High radiation doses, notwithstanding the short life period of the animals following irradiation (60 hr), provoke conspicuous destructive changes in the peripheral blood and hematopoietic tissue. (auth)

10731 HISTIDINE, ARGININE AND SH-GROUPS IN THE BLOOD CELLS AND BONE MARROW AND CHANGES IN THEIR CONTENT UNDER THE INFLUENCE OF X-RAYS. E. I. Terent'eva and A. I. Zosimovskaya (Central Inst. of Hematology and Blood Transfusion of Ministry of Health, USSR). Med. Radiol., 5: 20-4(Nov. 1960). (In Russian)

Experiments were staged on dogs and monkeys subjected to x-ray irradiation in a dose of 600 r. The most sensitive to irradiation in respect to the substances studied were the least differentiated elements, in which the content of arginine and histidine changes earlier than in the other cells, and the degree of their changes is higher. (auth)

10732 ON DISTURBANCES OF THE ORGANISM'S HUMORAL DETOXICATION MECHANISM IN AFFECTION WITH IONIZING RADIATION. P. N. Kiselev, E. V. Karpova, and V. N. Sivertseva (Central Inst. of Scientific Research in Medical Radiology, Ministry of Health, USSR). Med. Radiol., 5: No. 11, 30-6(Nov. 1960). (In Russian)

Data on the blood ability of animals to destroy toxins in health and in radiation sickness are given. (auth)

10733 THE MECHANISM OF DISTURBANCES OF PHAGOCYTIC PROCESSES IN THE RABBIT APPENDIX FOLLOWING X-RAY IRRADIATION. S. M. Sobolev and A. Ya. Fridenshtein (Gamalei Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). Med. Radiol., 5: No. 11, 36-40(Nov. 1960). (In Russian)

In whole-body irradiation (800 r) of rabbits with partial screening of the appendix, the principal changes in the appendix during the first 6 to 8 days depend on the direct effect of radiation. However, a number of changes occur also in the screened part of the appendix, associated with the distant effect of radiation in developing radiation sickness. The screened portion of the appendix exerts a definite influence on the irradiated one, this being manifested by earlier stages of completed phagocytosis restoration and regeneration of the lymphoid tissue of the irradiated portion. (auth)

10734 ERYTHEMA FROM FAST ELECTRONS. O. Trucchi (Università, Rome). Nuntius Radiol., 26: 922-39(Nov. 1960). (In Italian)

The morphological aspects and the evolution of skin erythema provoked by 15-Mev electrons administered in one sitting are described. The doses capable of determining the minimal and maximal erythema, epilation, desquamation, and epidermolysis in the different body areas were determined, and the influence of various factors which may modify the intensity and the course of the erythema are analyzed. Fast electron-induced erythema proved to be somewhat less marked than the erythema induced by the same dose of 55-kv x rays, but more precocious and severe than that due to filtered 200-kv x rays. The desquamation and epidermolysis appear by using higher doses of fast electrons than of x rays. The recovery period of the skin alterations is shorter for the fast electrons. (auth)

10735 EFFECT OF IONIZING RAYS ON MAN. PART II. EXTENT OF RADIATION DIAGNOSTICS IN SWITZERLAND. M. Schär, W. Minder, and A. Zuppinger (Universität, Bern). Praxis, 49: 779-85(Aug. 11, 1960). (In German)

The number of persons examined radiologically in Switzerland during the year 1957 was estimated by a sampling procedure. The data furnished by randomly selected physicians, dentists, hospitals, and other institutions included information about the kind of examination and age and sex of the patients. The per capita gonad dose resulting from diagnostic procedures was calculated on the basis of estimations and measurements made at the radiological institute of the University of Bern. The annual number of examinations per capita of the total population amounted to 0.34 for single fluoroscopies, 0.31 for radiographies, 0.14 for dental x-ray examinations, 0.06 for mass fluoroscopies, and 0.13 for mass miniature chest x-ray examinations. Approximately 0.51 x-ray films were used per person. The estimate of the annual genetically significant dose is 22.3 mr. Persons under 40 years of age receive a gonad dose of 26.6 mr per year and persons beyond this age 49.6 mr. The largest contribution to the gonad dose arises from relatively rare types of examination of the urogenital system and pelvic organs. The number of radiological examinations of the chest is outstanding, but these examinations account for only 5% of the genetically significant dose. (auth)

10736 A RADIOBIOLOGICAL ANALOGY BETWEEN MEASLES VIRUS AND TEMPERATE PHAGES. Paul H. Ackerman and Francis L. Black (Yale Univ. School of Medicine, New Haven). Proc. Natl. Acad. Sci. U. S., 47: 213-20 (Feb. 1961).

Measles virus was found to be more resistant to ultraviolet (uv) than to ionizing radiations. The capacity of monkey kidney cells to grow unirradiated measles virus or measles virus irradiated with gamma rays was not affected appreciably by uv irradiation of the cells. However, the capacity of cells to grow uv irradiated virus was reduced by uv irradiation of the cells. In contrast, uv irradiation of cells did not affect their capacity to grow uv-treated polio virus. These effects of radiation on the measles virus system are analogous to effects on the phage P22 system and are compatible with the hypothesis of cellular repair of damaged virus previously suggested for the temperate phage. (auth)

10737 ACTION OF X-IRRADIATION ON E. COLI. S. B. Bhattacharjee (Saha Inst. of Nuclear Physics, Calcutta). Radiation Research, 14: 50-5(Jan. 1961).

The radiation sensitivity of E. coli in the wet condition was compared with that in the dry condition. It was found that the radioresistance of the cells reached a saturation value after vacuum desiccation for about 24 hr. The values of 37% survival doses obtained were 3.6 and 12.4 kr for wet and 24-hr dried samples, respectively. By a comparison of the wet and dry irradiation data, the mean diffusion distance of the radicals formed during irradiation in the wet condition was estimated. The variation in the diffusion distance as a function of the number of radicals formed per primary ionization (Y) and the number of targets per cell

(n) was found out. This diffusion distance was found to be 20 A for Y = 4 and n = 20. (auth)

10738 STUDIES ON THE RADIATION INACTIVATION OF MICROORGANISMS. VII. NATURE OF THE X-RAY-INDUCED BREAKDOWN OF DEOXYRIBONUCLEIC ACID IN HAEMOPHILUS INFLUENZAE. Johan H. Stuy (Oak Ridge National Lab., Tenn.). Radiation Research, 14: 56-65(Jan. 1961).

X rays induce a vigorous DNA breakdown in logarithmic growth phase cells of Haemophilus influenzae. The effect is inhibited by high concentrations of citrate, suggesting the action of a DNase. The x-ray dose giving maximal effect was too small either to produce a direct split in a hypothetical DNase-inhibitor complex or to produce holes in a hypothetical membrane, which keeps the DNase separated from the cell DNA. It is argued that the DNase activation is one of the secondary x ray effects resulting from disorganization within the cell. Cysteamine or removal of oxygen from the cell suspension protected against both killing of the cells and induction of DNA breakdown. (auth)

10739 X-IRRADIATION OF THE GIANT AMOEBA, PELOMYXA ILLINOISENSIS. III. ELECTRON MICROSCOPY OF CENTRIFUGED ORGANISMS. E. W. Daniels and L. E. Roth (Argonne National Lab., Ill.). Radiation Research, 14: 66-82(Jan. 1961).

The electron microscope was used to study the strata in nonirradiated centrifuged donor amoebae with a view toward learning more about the areas that have demonstrated restorative capability after their transfer into supralethally irradiated amoebae. Strata that are characteristic of the centrifuged organisms are described in sequence from the centripetal to the centrifugal pole. (auth)

10740 EFFECTS OF TOTAL-BODY X-IRRADIATION IN UTERO ON EARLY POSTNATAL CHANGES IN NEURON VOLUMETRIC RELATIONSHIPS AND PACKING DENSITY IN CEREBRAL CORTEX. Kenneth R. Brizzee, Lyle A. Jacobs, and Xenia Kharetchko (Univ. of Utah, Salt Lake City). Radiation Research, 14: 96-103(Jan. 1961).

After exposure to a cumulative dose of 300 r of total-body x irradiation on gestation days 10 to 14 inclusive, only small differences in neuron nuclear volume, cytoplasmic volume, soma volume, and packing density between irradiated and control series were observed between the first and twentieth postnatal days. However, marked differences were observed in cortical thickness in five different areas at all developmental stages between the control and irradiated groups. The growth curves for cortical thickness for irradiated and control groups tended to be parallel in each specific area. Brain weight was found to be significantly less in the irradiated than in the control animals, as was cortical thickness. From the available data it appears that, although the total number of cells in the cortex is greatly reduced by in utero irradiation at the dose and rate levels employed, the surviving cells tend strongly to follow normal growth patterns and establish their normal spatial integrity. (auth)

10741 THE EFFECT OF X-IRRADIATION ON HeLa DURING DIFFERENT PHASES OF THE GROWTH CYCLE. Peter P. Ludovici, Roswitha A. Pock, Robert T. Christian, and Norman F. Miller (Univ. of Michigan, Ann Arbor). Radiation Research, 14: 131-40(Feb. 1961).

Monolayers of the established HeLa strain were exposed to various doses of x radiation during different phases of the growth cycle. The effects as measured by changes in cell and clone number were dependent on the radiation dose. Four days after irradiation was the optimum day for assessing irradiation damage in this system. Significant variations in the radiation sensitivity of HeLa during different stages of the growth cycle were observed by both assessing procedures. Cells in the logarithmic growth phase were most sensitive to radiation, followed in order by cells in the negative growth acceleration, stationary, and latent phases of the population cycle. The ranges of these differences were greater by cell than by clone count methods. The closest correlation between the two techniques was observed when radiation was administered during the logarithmic phase of growth. It is hoped that these studies may eventually facilitate the development of a satisfactory assay system for measuring the in vitro radiation sensitivity of short-term monolayer cultures of tumors, as well as the long-term monolayer cultures of established cell strains. (auth)

10742 DETECTION OF CHARACTERISTIC DIFFERENCES IN THE IRRADIATION SENSITIVITY OF FOUR HUMAN CANCER CELL STRAINS. Peter P. Ludovici, Roswitha A. Pock, Robert T. Christian, Gardner M. Riley, and Norman F. Miller (Univ. of Michigan, Ann Arbor). Radiation Research, 14: 141-8(Feb. 1961).

Monolayers of four human cancer cell strains were exposed to various doses of x radiation during different phases of their growth cycles. The effects as measured by changes in cell number were dependent on the radiation dose. The dose-response curve of each strain varied significantly when radiation was administered during different stages of the population cycle. With three strains, HeLa, RP Ca Vu I, and RP Ca Ov I, the cells at the beginning of the logarithmic growth phase were more sensitive to radiation than cells entering the negative growth acceleration phase. With the other strain, RP Ca Cx I, the reverse was true. Highly significant differences in the radiation sensitivity of the four cell lines were detected when radiation was administered during the fourth culture day, a period when the cells were entering the phase of negative growth acceleration. The characteristic differences appear to be consistent with the generally accepted radiotherapeutic susceptibility of the tumors from which the cell lines were originally derived. (auth)

10743 UNIQUE TISSUE DEPTH RESPONSE TO ELECTRON IRRADIATION. C. F. Tessmer, H. L. Andrews, and F. L. Jennings (Armed Forces Inst. of Pathology, Washington, D. C. and National Cancer Inst., Bethesda, Md.). Radiation Research, 14: 167-73(Feb. 1961).

Observations are presented on what appeared to be a unique depth effect of a monoenergetic electron beam (2.0 Mev). Changes related to the incident beam were identified in swine to a depth of 3 cm grossly and confirmed by histologic study as typical of radiation effect. This is in contrast to the generally accepted penetration of 2.0-Mev electrons of approximately 1 cm. Various factors of dosimetry and tissue effect are discussed, without a clear explanation of the lesion observed. The 1-cm beam penetration was confirmed in nonliving tissue-equivalent materials. (auth)

10744 DISTRIBUTION OF CYTOLOGICAL ABERRATIONS AFTER GAMMA IRRADIATION. Guru D. Pershad, S. A. Krane, C. C. Bowen, and H. T. David (Ames Lab., Ames, Iowa). Radiation Research, 14: 184-91(Feb. 1961).

Microsporocytes of four horticultural varieties of Lilium longiflorum were exposed to 20, 40, and 60 r of Co^{60} γ-irradiation at pachytene and diakinesis. Bridges and fragments were scored at anaphase I. It was observed that the total damage failed to follow the Poisson distribution. When the analysis was modified on the assumption that only a certain proportion of the damaged cells were scored, an

excellent fit was obtained to the Poisson distribution. It is suggested that cells with one or more bridges or fragments might take longer to reach anaphase than cells with no visible damage, and consequently such lagging cells are less apt to be scored. (auth)

10745 A DIRECT MEASUREMENT OF THE RADIATION SENSITIVITY OF NORMAL MOUSE BONE MARROW CELLS. J. E. Till and E. A. McCulloch (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Research, 14: 213-22(Feb. 1961).

A direct technique for the measurement of the number of cells in a bone marrow suspension capable of continued proliferation is described. The technique was used to measure the radiation sensitivity of normal mouse bone marrow cells and yielded a D_0 of 115 ± 8 rads. (auth)

10746 SPERM PRODUCTION IN SWINE AFTER EXPOSURE TO X-IRRADIATION. R. L. Willham and D. F. Cox (Ames Lab., Ames, Iowa). Radiation Research, 14: 223-9 (Feb. 1961).

The number of sperm per collection was followed for one year in swine exposed to 0, 300, 600, and 900 r of radiation directed to the testicles. The general response pattern in swine conforms to that outlined for other mammals. About 60 days has been estimated as the interval from primary spermatocyte to sperm in the ejaculate. These data indicate that the general recovery pattern, as measured by sperm number per collection between 70 and 300 days, is linearly related to dose on a logarithmic plot. This suggests that recovery is a function of the number of surviving spermatogonia. The length of time required for recovery to fertility appears to be longer in swine than in mice. (auth)

10747 EFFECT OF WHOLE-BODY X RADIATION ON ACID-SOLUBLE PHOSPHATE COMPOUNDS OF THE LIVER, MUSCLE, AND YOSHIDA SARCOMA OF THE RAT. F. Bresciani and K. Dose (Max-Planck-Institut fur Biophysik, Frankfurt am Main and Università, Naples). Radiobiol., radioterap. e fis. med. (3), 15: 312-25(1960). (In Italian).

Wistar rats after whole-body x irradiation (10 kr) were inoculated intraperitoneally with P^{32}-orthophosphate. Ninety minutes and 24 hr after the inoculation the animals were sacrificed and the acid-soluble phosphate extracted and analyzed by electrophoresis at high potential. Eleven fractions were separated from the liver and from the Yoshida sarcoma and five from the muscles. The specific radioactivity of each fraction was determined. The modifications of the specific radioactivity and of the stationary concentrations of the individual components of the acid-soluble phosphate fractions occurring after whole-body irradiation were discussed. (tr-auth)

10748 EFFECT OF RADIATION ON METASTATIC PELVIC LYMPH NODES JUDGED BY PELVIC VENOGRAMS. Sumner Holtz, William E. Powers, and Alfred I. Sherman (Washington Univ. School of Medicine, St. Louis). Radiology, 76: 287-9(Feb. 1961).

The response of metastatic lymph nodes in the pelvis to irradiation can be grossly demonstrated by pelvic venography. (auth)

10749 ERGASTOPLASMA AND NUCLEIC ACIDS IN THE CELLS OF THE PAROTID GLAND OF EPIMYS NORVEGICUS VAR. ALBINA (ERXL.) EXPOSED TO X RADIATION AND STIMULATED WITH PILOCARPINE. A. C. Levi and E. Caffaratti. Sperimentale, 110: 161-76 (May-June 1960). (In Italian)

The morphologic and histochemical changes occurring after x-irradiation and stimulation by pilocarpine were studied in the serous cells of the parotid gland of Epimys norvegicus var. albina (Erxl.) and classified in three groups, in relation to the time elapsed after irradiation. Sixty min after irradiation giant cells disappeared, while the large cells containing ergastoplasma decreased in number. A decrease of the nuclear DNA and of the fleeting RNA was observed, together with a relative increase of the permanent RNA. These changes became still more evident two days after irradiation, up to the 8th day. From the 8th to the 15th day the cells were gradually restored to normal morphologic and histochemical conditions. This stage was preceded by a temporary but decidedly outspoken increase of the nuclear DNA. In the first and second stage cells in "preprophase" were found and interpreted as blocked 'mitoses,' without any evident morphologic or histochemical alteration. It may be concluded that the morphologic and histochemical changes observed are due to the temporary inhibition of salivary secretion caused by the x-irradiation. The relative post-irradiation increase of the permanent RNA and the subsequent decrease of DNA indicate a twofold mechanism of transformation DNA ⇌ RNA. The role of ergastoplasma as cytoskeletal structure supporting RNA appears evident. The opposite behavior of the two fractions of RNA, connected with different metabolic dynamisms, proves that the ray-sensitivity must be interpreted essentially on a functional basis, in relation to the metabolic conditions existing at the moment of the irradiation. (auth)

10750 CLINICAL RESEARCH ON THE EFFECTS OF X IRRADIATION ON CARBOHYDRATE METABOLISM. Adolf Morczek and Klaus Neumeister (Universität, Leipzig). Strahlentherapie, 114: 187-95(Feb. 1961). (In German)

Examinations of the carbohydrate metabolism with the hlep of the double charge of glucose after Staub-Traugott and by means of measuring of the blood sugar in a state of fast have been carried out on 3 groups of patients, who had been subjected to an intensive x-ray radiation. The radiation of the thorax on patients with a sound metabolism had no influence upon the blood sugar in a state of fast and the curves of glucose charge. The radiation of the abdomen on patients with a sound metabolism remained without influence upon the blood sugar in fasting state, but on the other hand changed the glucose charge test. At the end of radiation the glucose charge curves ran parallel with the initial curves, however, they lay distinctly lower. With diabetics the blood sugar values in fasting state rose continuously in the course of the application of the radiation upon the thorax under otherwise equal conditions of diet and insulin treatment. The results reveal that the intermediary carbohydrate metabolism is not markedly influenced by an intensive x-ray radiation in patients with sound metabolism, that on the contrary, the radiation-induced organ damages can have secondarily an effect on the carbohydrate metabolism. With diabetics one must reckon with a certain charge of the metabolism, however, the indication for x-ray radiation is not restricted in the case of a well-balanced diabetes. (auth)

10751 THE EFFECTS OF EXOGENOUS AND ENDOGENOUS FACTORS ON THE RADIATION REACTION OF THE SKIN. PART I: EXPERIMENTAL STUDY OF THE EFFECT OF EXTERNA ON THE COURSE OF RADIATION ERYTHEMA. Karl Heinz Kärcher (Universität, Heidelberg, Ger.). Strahlentherapie, 114: 196-200(Feb. 1961). (In German)

The influence of different externa on the course of the x-ray erythema on rabbits ears is discussed. It is shown that the initial powder treatment of the skin is superior to

that of a salve-base treatment. The x-ray reaction of the skin corresponds in its intensity to the fat content of the applied salve. (auth)

10752 KREISLER YOUNG ANIMALS AFTER 200-r WHOLE-BODY X IRRADIATION OF PREGNANT WHITE MICE IN THE MAIN ORGAN-FORMING PERIOD. Johannes Trautmann (Städt. Krankenhaus Moabit, Berlin). Strahlentherapie, 114: 201-2(Feb. 1961). (In German)

Some Kreisler mice were observed after single- and short-period whole-body x-ray radiation with 200 r on the 13th day of pregnancy. Very probably it deals here with a rarely occurring embryo damage which has not yet been described. The Kreisler young animals behaved exactly as the Kreisler which P. Hertwig in the year 1942 described as new x-ray mutation. (auth)

10753 DETERMINATION OF THE RADIOSENSITIVITY OF DIFFERENT BONE GROWTH REGIONS USING Ca^{45} METABOLISM. Jaromir Kolar and Arnost Babicky (Charles Univ., Prague and Inst. of Biology, Czechoslovak Academy of Sciences, Prague). Strahlentherapie, 114: 265-9(Feb. 1961). (In German)

The radiation sensitivity of some bone segments and especially of the growth zones of white rats was examined with the help of Ca^{45}. The deviations in the specific activities corresponded not only to the delivered dosage but also to the growth activity of some of the bone segments. After large radiation doses and in more activity growth zones the radiation damage was also greater. These results should give reason in the clinical practice for greater caution in radiation treatment in the area of strongly growing epiphyseal zones (in the area of knee and wrist joints). (auth)

10754 RESEARCH ON BONE CALCIUM METABOLISM IN THE EPI- AND METAPHYSIS AFTER LOCAL X-IRRADIATION. PART II. Arnost Babicky and Jaromir Kolar (Charles Univ., Prague and Inst. of Biology, Czechoslovak Academy of Sciences, Prague). Strahlentherapie, 114: 270-3(Feb. 1961). (In German)

In continuing the tests with locally irradiated bones the deviations in the Ca^{45} metabolism of white rats after 750, 1500, 3000, and 5000 r were examined, whereby the changes up to the 110th day were followed up. After all radiation doses the specific activities in the irradiated bones were higher than in the nonirradiated; after 750 r, however, after 110 days an equilization was observed with the values in nonirradiated bones in the sense of a recuperation after radiation damage of the epiphyseal cartilages. (auth)

10755 DETERMINATION OF THE DECREASE OF BLOOD VESSELS USING INDIA INK INJECTIONS AFTER X IRRADIATION OF GUINEA PIG SKIN. Hans-Joachim Heite and Egon Macher (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 114: 274-80(Feb. 1961). (In German)

The skin on one side of the backs of 3 by 3 guinea pigs was radiated with 2000 r x-rays (short distance radiation conditions). After 4, 23, and 48 days the animals were killed and the blood-vessel system was filled with India ink. Histological sections were prepared from the x-ray radiated areas and the nonradiated control areas of the opposite side in which the number and size of the blood-vessel cross sections were defined. The number of vessels 4 days after radiation with 2000 r is unchanged, after 23 days a little, compared with that of the nonradiated control area, and after 48 days considerably reduced (to 35.9%). In the comparison of the frequency distribution of the blood-vessel cross sections it results that in the decrease of the vessels circulated and filled with India ink no definite vessel size is favorably shared. No displacement of any kind of the center of gravity in the vessel size takes place. (auth)

10756 THE DEPENDENCE OF THE RATE OF RADIO-INDUCED TRANSLOCATIONS AND RECESSIVE SEX-LINKED LETHAL FACTORS ON THE SPERMATOGENESIS STAGE IN DROSOPHILA MELANOGASTER. H. Traut. Z. Vererbungslehre, 91: 201-5(1960). (In German)

Utilizing a dual-purpose stock of Drosophila melanogaster the dependence of radiation induced translocations and recessive sex-linked lethals on the stage of spermatogenesis was investigated and is discussed. A formerly existing discrepancy in the dependence of radiation induced translocations on the stage of maturity of the irradiated germ cells is explained by differences in experimental procedure: Besides an adequate subdivision of the brood pattern an excess of P-females in the ratio of 3 : 1 was necessary for obtaining maximum sensibility expected in the region of immature germ cells. (auth)

10757 THE ROLE OF FREE RADICALS IN THE LETHAL EFFECTS OF X-RAYS IN DRY BACTERIAL SPORES. E. L. Powers, C. F. Ehret, and B. Smaller (Argonne National Lab., Ill.). p. 351-66 of "Free Radicals in Biological Systems." New York, Academic Press, Inc., 1961.

The evidence for the role of free radicals in the lethal effect of x rays on dry spores of Bacillus megaterium consists of the prevention of approximately half the radiation effect by postirradiation heat-treatment, as well as by postirradiation nitric oxide treatment. The interpretation is that nitric oxide and heat-treatment remove free radicals that would have damaged the spore if they had not been removed. An important aspect of this effect is that these free radicals are rapidly made irreversibly toxic to the cells by reaction with oxygen. In the absence of oxygen, they are slowly fixed in the lethal state. The substitution of D_2O for the H_2O of the spore decreases over-all sensitivity to radiation by about 15%, but it appears to have no effect on the radicals involved in the inactivation process. Physical analysis of the irradiated spores for presence of radicals was made by microwave spectrometry. The physical and biological evidence for free radical involvement in the damage produced by x rays in the dry spores is in agreement; there are some equally interesting nonparallelisms, but these are open to several reasonable explanations yet to be resolved experimentally. Further investigation will undoubtedly prove them and could conceivably constitute important information concerning the role of free radicals in the biological effects of high-energy radiations. (auth)

Radiation Sickness

10758 (JPRS-7666(p.62-73)) PROTEIN METABOLISM AND IMMUNOLOGICAL CHARACTERISTICS OF CELL ORGANOIDS IN ACUTE RADIATION SICKNESS. L. I. Il'ina and R. V. Petrov. Translated from Tsitologiya, 2: No. 3, 296-303(1960).

The data obtained constitute evidence to the effect that disturbances in protein metabolism occur in all cell organoids under the influence of radiant energy. A number of pathological phenomena observed in the irradiated organism may be associated with the occurrence of antigenic properties not characteristic of the normal in the cytoplasm granules. Specifically, the altered tissue proteins can, on entering the blood, be the material substrate of toxemia and

the cause of an immunological reorganization of the body, resulting in sensitization, and the appearance of cytotoxic antibodies in the blood. (auth)

10759 SURVIVAL OF PLATELETS TRANSFUSED INTO THROMBOCYTOPENIC RECIPIENTS. Dudley P. Jackson and Julius R. Krevans (Johns Hopkins Univ., Baltimore). Bull. Johns Hopkins Hosp., 107: 349-58(Dec. 1960).

Eight dogs were rendered thrombocytopenic by the administration of 450 to 500 r whole-body radiation. One dog was rendered thrombocytopenic by an injection of rabbit anti-dog platelet serum. After thrombocytopenia developed, compatible homologous blood was transfused either without phlebotomy, or by exchange transfusion or cross-transfusion. The viability of the platelets in the transfused blood was determined by observing the ability of the transfused platelets to survive in the thrombocytopenic recipients. The platelets contained in fresh blood were viable as indicated by circulation of most of the transfused platelets and the subsequent slow disappearance of the platelets from the recipients' circulation. Survival of the platelets was not adversely affected by the use of uncoated glass containers. The platelets contained in stored blood were less viable as indicated by initial survival of fewer of the transfused platelets and the subsequent more rapid disappearance of the platelets from the recipients' circulation. Platelet viability was inversely related to the time of storage of the blood. (auth)

10760 EVALUATION AND MANAGEMENT OF THE HEAVILY IRRADIATED INDIVIDUAL. V. P. Bond, T. M. Fliedner, and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). J. Nuclear Med., 1: 221-38(Oct. 1960). (BNL-4886)

The management of the heavily radiated individual has been discussed. There is nothing mysterious about the acute radiation syndrome in man, and the manifestations seen are those to be expected in light of the underlying cellular, organ, and physiological changes known to result from the exposure. It is possible, on the basis of signs and symptoms presented and aided to some extent by physical estimates of dose, to place the exposed individual into very broad categories with respect to the severity of exposure, therapy that may be indicated, and prognosis. It is stressed that under no conditions should an individual be treated on the basis of physical estimate of dose or category and that therapy should be given an individual only as and when indicated by clinical signs and symptoms, including laboratory data. Therapy should be on an individual basis always and should be given when indicated and not on a prophylactic basis. With severe marrow hypoplasia and depletion of the peripheral blood neutrophils and platelets in the third or fourth week following exposure, it is possible in a high per cent of casualties to tide the patient over with functional replacement therapy, involving principally antibiotics and fresh platelets, until the individuals' marrow regenerates spontaneously. At higher doses, with complete marrow aplasia and depletion of the peripheral blood elements in the second week or earlier, serious consideration must be given to bone-marrow transfusions. The efficacy of this procedure in man has not been established adequately as yet. 39 references. (auth)

10761 ANTIHISTAMINES FOR THERAPY OF RADIATION SICKNESS. B. Bošnjaković, M. Bekerus, Z. Merkaš, D. Marković, and S. Pendić. Med. Klin. (Munich), 55: 315-17(Feb. 1960). (In German)

Histamine plays a significant roll in the development of radiation sickness. With antihistamines satisfactory treatment results are obtained, provided the doses from the beginning are high enough. Andantol was found to be the best drug in tests on 130 patients. (tr-auth)

10762 REACTIVITY CHANGES OF LARGE BLOOD VESSELS IN ACUTE RADIATION SICKNESS. K. B. Tikhonov (Kirov Military Medical Academy of the Order of Lenin). Med. Radiol., 5: 11-14(Nov. 1960). (In Russian)

A study was made of arteries of the pelvis and posterior extremities by the method of angiography in 8 dogs before and after irradiation (500 r). At the peak of acute radiation sickness, a sharp constriction of all arteries of the pelvis and limbs was recorded. (auth)

10763 MINERAL METABOLISM CHANGES IN HARD DENTAL TISSUES IN CHRONIC RADIATION SICKNESS. A. A. Prokhonchukov (Moscow Medical Inst. of Stomatology). Med. Radiol., 5: No. 11, 41-6(Nov. 1960). (In Russian)

Studies on the exchange of P^{32} and Ca^{45} in hard dental tissues of white rats in chronic radiation sickness are described. Mineral metabolism disturbances in the teeth occur long before morphological changes of hard dental tissues. These disorders are considered to be one of the essential pathogenic factors conducive to the appearance of morphological lesions of teeth during the action of ionizing radiation. (auth)

10764 DOGS THAT SURVIVE "LETHAL" EXPOSURES TO RADIATION. E. B. Hager, J. A. Mannick, E. D. Thomas, and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Radiation Research, 14: 192-205(Feb. 1961).

In the course of 2 years' study of the treatment of lethal total-body radiation exposure in the dog a group of 37 survivors was accumulated. The exposures survived were 600 to 1800 r of γ- or x-ray administered continuously at dose rates of 2 to 18 r/min. The apparently successful treatments used were transfusions in three instances, implantation of allogenic (homologous) marrow in four instances, and infusion of a stored sample of autologous marrow in thirty instances. Surviving animals 6 to 20 months after exposure appear in normal health. Their coats are gray; otherwise their appearances and behavior are normal. Three have been given opportunity to breed and have produced normal offspring. The 4 dogs treated by infusion of allogenic marrow from another dog show continued hematologic evidence of chimerization. They are males. Their peripheral blood contains segmented polymorphonuclear leukocytes bearing the sex marker of the female. In the one instance determined the blood group also is that of the donor rather than the group originally present in the irradiated animal. (auth)

10765 EFFECT OF DOSE SIZE ON RATE OF RECOVERY FROM RADIATION DAMAGE IN MICE. John B. Storer (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Radiation Research, 14: 206-12(Feb. 1961).

Latent residual injury contributing to the acute lethal response in RF/J mice 80 to 120 days old after x ray doses of 100 to 650 r was estimated at 2 days after exposure by determining the additional dose required to produce 50% mortality in 30 days. The fraction of latent damage repaired, as measured by this technique, decreased progressively with increasing dose. On the assumption that the recovery pattern can be described by a simple exponential equation, recovery rate constants for the various doses were estimated. It was concluded that the recovery rate decreased inversely with the square of the dose, and it was suggested that equations using recovery rate constants should be modified accordingly. When repair was expressed in terms

of roentgens of latent damage repaired, it appeared that a maximum rate of repair occurred at a dose of 300 r. Higher doses severely depressed the repair mechanism. (auth)

10766 THE GLYCO-ACTIVE CORTICOIDS (PREDNISONE AND PREDNISOLONE) IN THE MEDICAL THERAPY OF IRRADIATION. G. Pisani and U. Nuvolone (Istituto Radiologico e Sezione Oncologica, Novara, Italy). Radiobiol., radioterap. e fis. med. (3), 15: 326-40(1960). (In Italian).

The experience gained in a 4-yr clinical trial of the use of prednisone and prednisolone for the cure of general and localized postirradiation reactions are reported. The method of treatment used, the therapeutic results, and the side effects are discussed. Theoretical suppositions justifying the use of glyco-active corticoids are reviewed to emphasize their utility in therapy of radiation sickness. (tr-auth)

10767 RESEARCH IN BIOLOGICAL RADIATION PROTECTION. PART XXXIX: THE SIGNIFICANCE OF THE SPLEEN IN RADIATION INJURY. Hans-Joachim Melching, Otfried Messerschmidt, and Christian Streffer (Universität, Freiburg i. B.). Strahlentherapie, 114: 179-86 (Feb. 1961). (In German)

A protection effect in the sense of an increased survival rate is attained by means of a splenectomy on white mice 14 days before a sublethal whole-body radiation. This protective effect is raised through the simultaneous administration of adenosinetriphosphoric acid before the radiation and lessened through the administration of serotonin. A part of the increased excretion of taurine determined in the urine of the animals following a sublethal whole-body radiation is probably due to the influencing and damaging of the spleen. (auth)

10768 MODIFICATION OF DELAYED SOMATIC EFFECTS OF IONIZING RADIATION. T. T. Odell, Jr., G. E. Cosgrove, and A. C. Upton (Oak Ridge National Lab., Tenn.). p.303-15 of "Radiation Protection and Recovery." New York, Pergamon Press, 1960.

The induction of delayed somatic effects of ionizing radiation is influenced in many instances by physiological and experimental variables that affect the induction of early radiation injuries. Measures that protect when carried out during irradiation include lowering of oxygen tension, administration of sulfhydryl compounds, and tissue shielding. After irradiation, protection against late effects may be afforded by replacement of damaged cells through transplantation, parabiosis, or partial shielding; by correction of endocrine disturbances through administration of hormones; and by various other procedures. The dose-reducing effectiveness of these measures is not yet well defined, and their protective action varies for different types of effects and under different irradiation conditions. Although the practical usefulness of these measures has yet to be fully evaluated, study of them has contributed significantly to our knowledge of the pathogenesis of delayed radiation effects and has given promise that effective methods may ultimately be found to protect against many, if not all, delayed forms of radiation injury. 61 references. (auth)

CHEMISTRY

General and Miscellaneous

10769 (AD-231572) RARE EARTH CHALCOGENIDES. Technical Progress Report for period September 1, 1959–November 15, 1959. August R. Freda (Pittsburgh. Univ.). Nov. 30, 1959. Contract NOBs-77068. 2p.

Measurements were made of the resistivity of rare-earth oxides before and after sintering. All of the undoped green compacts of both the commercially pure rare-earth oxides and the high-purity ceric oxide revealed the same resistivity of approximately 10^6 ohm-cm. This was concluded to be due to the moisture content of the compacts since, after sintering, the resistivity of the compacts approached infinity. The doped compacts showed the same resistivity. It is believed that the doping with either selenium or tellurium during sintering was unsuccessful due to the low boiling points of these additions. (M.C.G.)

10770 (AFOSR-TN-60-1455) THE STOICHIOMETRY AND RESISTIVITY OF PrO_x. A. F. Clifford and Paul A. Faeth (Purdue Univ., Lafayette, Ind.). Nov. 11, 1960. Contract AF18(603)-45. 14p.

Praseodymium oxide (PrO_x) has several stable intermediate compounds between $PrO_{1.50}$ and $PrO_{2.00}$. At constant temperature the composition may be expressed as a function of temperature. It was found that in the critical regions, the pressure-ascending isotherms are not superimposable on the pressure-descending isotherms. A hysteresis was observed between most of the neighboring pairs of compositions. Isotherms were measured using a quartz-beam microbalance. It was found that for large x values, $PrO_{1.83}$, PrO_x is an n-type semiconductor; whereas for low x values, Pr_2O_3, it is p-type. The resistance of the sample was measured at temperatures to 1100°C. In a plot of log R(R = resistance) vs. 1/T, the resistance at 925°C appeared to be a pivot point, indicating the transition temperature. The vacuum isobars also showed several linear regions with breaks at significant temperatures. (M.C.G.)

10771 (GAMD-960) KINETIC LIMITATIONS TO CARBON DEPOSITION. D. V. Ragone (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 3, 1959. 13p. Contract AT(03-4)-187. (MGCR-M-215)

Some calculations on rates of transport of carbon-bearing impurities to heat-transfer surfaces are presented. A brief review of carbon monoxide decomposition on various surfaces is given. (auth)

10772 (NP-9283) SYNTHESIS AND EVALUATION OF THERMALLY STABLE POLYMERS. Progress Report No. 2, June 1, 1960 to September 1, 1960. PHASE I. POLYMER SYNTHESIS. G. P. Brown and A. Goldman. PHASE II. POLYMER EVALUATION. Charles D. Doyle (General Electric Co. General Engineering Lab., Schenectady, N. Y.). May 15, 1960. Contract AF33(616)-7076. 56p.

Submitted by General Electric Co., Pittsfield, Mass.

Synthesis directed toward the production of m-polyphenyl ethers was continued. Polymeric materials having molecular weights of the order of 3000 to 6000, by end group analysis, were prepared from self-condensation of alkali metal salts of m bromophenol. A minor portion of the effort was directed toward starting the investigation of suitable routes to perfluoroaromatic intermediates. Investigation of replacement of bromine by fluorine in 2, 3, 4, 6-tetrabromophenol is under way. First-order, second-order, and "apparent" second-order transitions in polymers are discussed, together with oscillatory and nonoscillatory methods of observing them. (W.L.H.)

10773 (TID-11804) HETEROAROMATIC BORON COMPOUNDS AS POTENTIAL AGENTS FOR NEUTRON IRRADIATION THERAPY. Michael J. S. Dewar (Chicago. Univ.). [nd]. Proposal for Renewal of Contract AT(11-1)-889. 10p.

An investigation was made of the preparation of stable organoboron compounds that might be of value in neutron irradiation therapy. Recent work has shown that unusually

stable boron compounds can be obtained by including boron in aromatic rings. Compounds of this kind can be derived formally from any normal aromatic system by replacing one carbon atom by boron and another by nitrogen or oxygen. In order that the compounds should be stable to hydrolysis at least one ring atom adjacent to boron must be carbon. Our object has been first to prepare soluble derivatives of the ring systems previously studied and second to prepare boron analogues of purine nucleotides in the hope that they might be included directly into the nuclei of tumor cells. Results are reported on attempts to prepare derivatives of 10,9-borazarophenanthrene, borapurines, and organometallic derivatives of 1-methylimidazole. (C.H.)

10774 (USNRDL-TR-492) DESIGN AND PERFORMANCE OF A PLASTIC-LINED ULTRAFILTER. C. M. Callahan and J. R. Lai (Naval Radiological Defense Lab., San Francisco). July 8, 1960. 38p.

A lucite-lined high-pressure ultrafilter was designed and tested for use with corrosive inorganic solutions. The design and construction materials used were such that solution-metal interfaces were eliminated in the apparatus. The filter was also designed for ease in assembly and operation. Of three commercial dialyzing membranes investigated, the filtering characteristics of two were found to be satisfactory for separating colloidal materials. The pore sizes of the membranes were determined by means of a water flow method. Filtration of distilled water, hydrochloric acid, and several salt solutions, to determine whether filtration rate and solute concentration are constant, showed that the rate of filtration became a maximum early and then slowly decreased. Early fractions of the filtrate showed lower solute ion concentrations than later fractions, indicating that the membrane exerted a screening or retarding effect on solute ions. Filtrations with radioactive tracers were also made to determine the extent of adsorption on the components of the apparatus. These experiments verified the screening effect and showed that adsorption could be a serious problem. Methods for minimizing adsorption were devised, especially for working with seawater media, and tests were made with the radiocolloids Zr^{95}-Nb^{95} to show that these were effectively separated by ultrafiltration. (auth)

10775 (WADD-TR-60-315(Pt.II)) SYNTHESIS OF NITROGEN-CONTAINING AND HETEROCYCLIC FLUID SYSTEMS. PART II. THE PREPARATION OF TRIAZINE, QUINOLINE AND TERTIARY AMINO DERIVATIVES. E. H. Kober, B. F. Clark, W. J. Schnabel, and H. A. Schroeder (Olin Mathieson Chemical Corp., New Haven). Nov. 1960. 111p. Contract AF33(616)-6342. (OMCC-5894-FSRII)

Results are presented of an investigation toward the synthesis of nitrogen-containing and heterocyclic compounds as potential thermally stable base stock fluids. Work on substituted derivatives of melam and melem was continued. It is concluded that in these two classes of compounds thermal stability approaching the 1000°F goal can only be obtained with substituents which impart very high melting points to the resulting compounds. Further investigations were concerned with the synthesis of substituted s-triazines, quinolines, benzo(h)-quinolines, and silicon-containing aromatic tertiary amines. Many preparations showed melting points below 100°C, some had good thermal stability at 800°F, but only few exhibited fair stability at 900°F, which appears to be the upper thermal stability limit of these compounds. (auth)

10776 (AEC-tr-4340) ASCORBIC ACID 1 (VITAMIN C) AS A REAGENT. Virgilio Lucas. Translated from Anales real acad. farm., 17: 139-42(1951). 12p.

The values of ascorbic acid for use as a reagent is discussed. It is noted that this compound has oxy-reducing qualities which makes possible its recognition as well as identification of other substances with which it reacts. The general physical and chemical properties of the substance are summarized. (J.R.D.)

10777 (AEC-tr-4392) METAL-ORGANIC COMPLEX COMPOUNDS. G. Wittig. Translated for Oak Ridge National Lab. from Angew. Chem., 62: 231-6(1950). 35p. (Includes original, 6p.).

A review of the technology on metal-organic complex compounds is presented. The possibility that decidedly metal-organic compounds, in whose molecules the metal is linked with hydrocarbon bonds, are capable of complexing into compounds of higher orders is examined. Several experiments are described which show that a new class of compounds and new reaction possibilities were made available by means of phenyllithium. (J.R.D.)

10778 (CEA-tr-R-540) DISSOLUTION DE L'ALUMINIUM DANS DES SOLUTIONS DE SOUDE CAUSTIQUE. (Dissolution of Aluminum in Solutions of Caustic Soda.) A. G. Lochkorev. Translated into French from Zhur. Priklad. Khim., 30: 1861-3(1957). 9p.

Results are given from a kinetic study of the dissolution without residue of aluminum in NaOH solutions. The solutions containing 6.1, 3.05, and 1.5 g/l at 17° were placed in small cavities in the aluminum. Four drops of each solution were used. The aluminum concentration was followed by a spectrophotometric technique using aluminon. It was found that the rate of the reaction in the first phase is determined by the rate of continuous diffusion of alkali toward the hydroxide surface formed on the metal. In the second phase the rate depended on the rate of discontinuous diffusion. (T.R.H.)

10779 (CEA-tr-A-761) CRISTALLISATION DE QUELQUES OXYDES HYDRATES. (Crystallization of Some Oxide Hydrates). R. Fricke. Translated into French from Z. anorg. u. allgem. Chem., 166: 245-8(1927). 25p.

Crystallization studies on BeO hydrate, $Al(OH)_3$, $Zn(OH)_2$, $Cr(OH)_3$, and $Mg(OH)_2$ are reviewed. The studies were particularly involved with the effects of aging on the solutions. (38 references.) (T.R.H.)

10780 (NP-tr-518) SILICONES: ORGANOSILICON COMPOUNDS, THEIR PREPARATION, PROPERTIES AND USE. (Silikony: Organokremicite Slouceniny, Jejich Priprava, Vlastnosti a Pouziti). Vladimir Bazant, Vaclav Chvalovsky, and Jiri Rathousky. Translation of a publication of State Publishing House of Technical Literature, Prague, 1954. 535p. (MCL-186/V).

A treatise is presented on organic compounds of silicon, their nomenclature, and methods of their preparation on laboratory and industrial scales. It describes the chemical properties and reactions of silicon and its compounds, the analytical methods and the physical chemical research in organosilicon chemistry, the main types of organosilicon polymers and the method of their preparation. Included are the practical uses of organosilicon monomers and polymers as impregnating agents, silicone fluids, lubricants, electroinsulating and protective lacquers, molding resins, and silicone rubber. (W.L.H.)

10781 (SCL-T-333) DUST REMOVAL AND WASHING GASES BY MEANS OF A CYCLONE-DROPLET LAYER. (THEORY AND APPLICATION OF LIQUID-DROPLET SUSPENSION). W. Muhlrad. Translated by Marcel I. Weinreich fron Technische Uberwachung, 11: (LIV), No. 1, 16-17 (Jan. 1959). 3p.

An apparatus consisting of a vertical downward tapering tube is described in which gas flow traverses upward through water spray. The process is designed to clean gases by exchange between the water and gas using an action that progresses as if it were the entire mass of liquid that participates, and not the actually occurring momentary surface contracts. Industrial applications of the principle are noted. (J.R.D.)

10782 A NEUTRON DIFFRACTION REFINEMENT OF THE LOW TEMPERATURE PHASE OF $NaNO_2$. M. I. Kay and B. C. Frazer (Brookhaven National Lab., Upton, N. Y.) Acta Cryst., 14: 56-7(Jan. 10, 1961). (In English) (BNL-4585)

The structural nature of the spontaneous polarization of $NaNO_2$ below its transition point was investigated by neutron diffraction. A set of (0kl) single crystal data was collected at room temperature. The positional coordinates and their standard deviations were compared with those of Truter and Carpenter. The spontaneous polarization calculated on the basis of simple Na^+, N^{3+}, and O^{2-} ions was 74 μ coulombs/cm^2, which was off by an order of magnitude from the observed value of 7 μ coulombs/cm^2. This was a result of the highly covalent nature of the nitrite group. (M.C.G.)

10783 A NEUTRON DIFFRACTION REFINEMENT OF THE CRYSTAL STRUCTURE OF DIMETHYLGLYOXIME. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.). Acta Cryst., 14: 95-100(Feb. 10, 1961). (BNL-4377)

Neutron diffraction data for two zones of dimethylglyoxime were refined and the locations of all atoms, including hydrogen, determined. The structure has the normal O–H···N hydrogen bond rather than the zwitterion structure which was previously proposed. The O–H bond length is 1.02 ± 0.04 A, and the O–H···N hydrogen bond angle is 140 ± 3°, a significant departure from the usually assumed linear configuration. The methyl group may be somewhat distorted from the ideal tetrahedral shape. The other bond lengths and angles, although in some disagreement with the x-ray results, are in good agreement with those in related compounds. Of particular interest is the difference of 0·08 A in the two C–C single-bond lengths. (auth)

10784 SOME ASPECTS OF DEUTERIUM ISOTOPE EFFECTS IN MECHANISM STUDIES. Clair J. Collins (Oak Ridge National Lab., Tenn.). Ann. N.Y. Acad. Sci., 84: 603-7(Nov. 25, 1960).

Three obstacles to the deduction of proper conclusions from isotopic data are discussed: (1) intermolecular isotope effect: the reactions A → B and A* → B*, where A* and B* are labeled reactant and product, are treated, and graphs are given which show that for sizable isotope effects, a considerable fraction of A* remains after 99.9% reaction of A; consequently tracer experiments are futile; (2) Difficulty in distinguishing stereoselectivity from the intramolecular isotope effect; and (3) Difficulty in distinguishing primary and secondary isotope effect. (D.L.C.)

10785 SYNTHESIS AND PURIFICATION OF SEXIPHENYL FOR SCINTILLATOR. Tadashi Nozaki, Michiko Tamura, Yuhei Harada, and Kazuo Saito (Tokyo Univ. and Electrical Communication Lab., Tokyo). Bull. Chem. Soc. Japan, 33: 1329-32(Oct. 1960). (In English)

A process is given for the synthesis of sexiphenyl from terphenyl. A new method is given for obtaining from terphenyl 60% yield of 4-nitroterphenyl which can be converted successively into 4-aminoterphenyl, 4-iodoterphenyl, and finally sexiphenyl, the latter conversion taking place by Ullmann condensation with copper. Sexiphenyl can be purified by repeated zone refining and vacuum sublimation. (D.L.C.)

10786 INTERACTION OF ZIRCONIUM AND HAFNIUM HYDROXIDES WITH SODIUM HYDROXIDE. I. A. Sheka and Ts. V. Pevzner (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 8, 1090-4(1960). (In Ukrainian)

The interaction of zirconium and hafnium hydroxides with sodium hydroxide in aqueous solutions was studied by measuring the solubilities. It is found that in 1 to 10N solutions of sodium hydroxide, zirconium and hafnium hydroxides formed $Zr(OH)_5^-$ and $Hf(OH)_5^-$ ions. With a greater concentration of NaOH, $Zr(OH)_6^{2-}$ and $Hf(OH)_6^{2-}$ ions were formed. The composition of the solid phase evolved from a solution of hafnium hydroxide in concentrated alkali (16N and over) corresponded approximately to formula $Na_2[Hf(OH)_6]$. The solubility of zirconium hydroxide in alkaline solutions (under 16N NaOH) was less than that of hafnium hydroxide. (auth)

10787 BINUCLEAR COMPLEX IONS. III. FORMATION OF PEROXO AND CYANO BRIDGED COMPLEXES BY OXIDATION OF THE PENTACYANO COMPLEX OF COBALT(II). Albert Haim and W. K. Wilmarth (Univ. of Southern California, Los Angeles). J. Am. Chem. Soc., 83: 509-16(Feb. 5, 1961).

The binuclear ions $[(NC)_5Co^{III}OOCo^{III}(CN)_5]^{6-}$ and $[(NC)_5Fe^{II}CNCo^{III}(CN)_5]^{6-}$ were prepared by oxidation of the pentacyano complex of Co(II) with O_2 and $Fe(CN)_6^{4-}$, respectively. The one electron oxidation of these binuclear ions yields $[(NC)_5Co^{III}OOCo^{IV}(CN)_5]^{5-}$ and $[(NC)_5Fe^{III}CNCo^{III}(CN)_5]^{5-}$. Oxidation of the pentacyano complex of Co(II) with H_2O_2, $S_2O_8^{2-}$ and $[(NC)_5Co^{III}OOCo^{III}(CN)_5]^{6-}$ yields $(NC)_5CoOH_2^{2-}$ as the major product in each instance. Only $Cr(CN)_6^{3-}$ appears to be formed in the oxidation of the Cr(II) cyanide complex with either oxygen or hydrogen peroxide. $(NC)_5CoOH_2^{2-}$ undergoes spontaneous polymerization in solution and in the solid state. The mechanism of formation of the various complex ions is discussed in terms of outer sphere and bridged-activated complexes. (auth)

10788 BINUCLEAR COMPLEX IONS. IV. AN INVESTIGATION OF THE MECHANISM OF OXYGENATION OF THE CHROMIUM(II) ION IN AMMONIACAL SOLUTION USING O^{18} LABELLED OXYGEN. T. B. Joyner and W. K. Wilmarth (Univ. of Southern California, Los Angeles). J. Am. Chem. Soc., 83: 516-20(Feb. 5, 1961).

A study was made of the extent of the labeling of the bridging oxygen atom of the $[(H_3N)_5Cr-O-Cr(NH_3)_5]^{4+}$ ion, formed by oxygenation of the Cr(II) ion in ammoniacal solution. Under all conditions the labeling was extensive but never complete. The percentage labeling varied only over the range 40 to 70% despite an 80°C variation in reaction temperature and a considerable variation in pH and Cr(II) concentration. On the basis of these results and other available information, it is possible to deduce a plausible path for the oxygenation process. In this mechanism both the binuclear $[(H_3N)_5Cr-O_2-Cr(NH_3)_5]^{4+}$ ion and a Cr(IV) complex, the $[(H_3N)_5Cr(OH)]^{3+}$ ion, play important roles as transient intermediates in the over-all reaction. (auth)

10789 THE ARRHENIUS PARAMETERS OF THE DEUTERIUM ISOTOPE RATE EFFECT IN A BASE-PROMOTED ELIMINATION REACTION: EVIDENCE FOR PROTON TUNNELLING. V. J. Shiner, Jr. and Morris L. Smith (Indiana Univ., Bloomington). J. Am. Chem. Soc., 83: 593-8(Feb. 5, 1961).

The rates of reaction of 1-bromo-2-phenylpropane and the 2-deuterio analog with sodium ethoxide in ethanol were

determined from 5 to 55°C. The reaction product was shown to be quantitatively α-methylstyrene with no competing substitution reaction. By reference to the infrared spectra taken with a lithium fluoride prism instrument, the tertiary carbon-hydrogen and carbon-deuterium vibrational stretching frequencies of these compounds were assigned as 2904 and 2160 cm^{-1}, respectively. The approximately doubly degenerate bending frequencies of these bonds were tentatively assigned as 1299 and 934 cm^{-1}, respectively. The experimentally determined Arrhenius equations are: log $k_H = 11.033 - (20{,}655/2.303RT)$; log $k_D = 11.443 - (22{,}406/2.303RT)$; and log $(k_H/k_D) = -0.437 + (1{,}790/2.303RT)$. An upper limit for the isotope activation energy effect, neglecting tunneling, was estimated using the observed ground-state vibrational frequencies and found to be significantly less than that obtained experimentally. The frequency factors are abnormal in that the one for the deuterium compound is almost three times that for the hydrogen analog. These apparent discrepancies between the experimental and theoretical activation parameters are rationalized on the basis of nonclassical barrier penetration by the proton. The proton tunneling through the potential barrier effectively increases the activation energy difference for the two isotopes. The general utility of the deuterium isotope rate effect in mechanistic studies is not greatly altered by the occurrence of tunneling. (auth)

10790 EFFECT OF SOLVENT COMPOSITION ON THE KINETICS OF REACTIONS BETWEEN IONS AND DIPOLAR MOLECULES. PART III. E. A. S. Cavell and J. A. Speed (The University, Southampton, Eng.). J. Chem. Soc., 226-31(Jan. 1961).

A kinetic study of the exchange of radioactive iodine between sodium iodide and n-butyl iodide was made in a series of mixtures of methyl cyanide and methanol as solvents, with carrier-free sodium radioiodide providing all the iodide ions present initially. The reaction rate falls as the concentration of methanol is increased, and this reduction in rate is discussed in terms of a specific interaction between iodide ions and methanol molecules. Changes in dielectric constant are small and have been neglected. It was also found, by the use of various phenols in place of methanol, that the capacity of a hydroxylic compound to retard the iodine exchange reaction increases with its strength as an acid. However, the integrated intensity of the infrared absorption band associated with the O–H stretching vibration appears to be a better measure than its acid strength of the capacity of a phenol to retard iodine exchange. Spectroscopic evidence for hydrogen bonding between anions and hydroxylic molecules is discussed briefly. (auth)

10791 CONDUCTIVITIES IN EMULSIONS. Robert E. Meredith and Charles W. Tobias (Univ. of California, Berkeley). J. Electrochem, Soc., 108: 286-90(Mar. 1961).

The dependence of the conductivity of water-propylenecarbonate emulsions on volume fraction f of the dispersed phase, on the conductivities of the continuous phase k_c, and of the discontinuous phase k_d, was measured in the ranges of $0 < f < 0.5$ and $0.172 < k_d/k_c < 101$. The results indicate that when $f > 0.2$ neither Maxwell's equation nor Bruggemann's approximation represents the behavior of data satisfactorily. In an attempt to take into account the interaction of fields around particles of the dispersed phase, a simple approximation is proposed, based on Maxwell's equation. In the range of conductivities investigated in the present study the new equation represents the conductivity of emulsions with reasonable accuracy. (auth)

10792 THE HYDROGEN–VANADIUM(V) OXYTRICHLORIDE REACTION. R. E. McCarley and J. W. Roddy (Ames Lab., Ames, Iowa). J. Inorg. & Nuclear Chem., 15: 293-6(1960). (IS-58). (In English)

The reaction of hydrogen and $VOCl_3$ was investigated over the temperature range from 500 to 850°C. Pure VOCl was obtained as the reaction product at 600 to 635°C; but at higher temperatures mixtures of V_2O_3, VCl_2, and VOCl resulted. Thermal decomposition of VOCl at 650 to 900°C proceeded with the formation of V_2O_3, VCl_2, VCl_3, and VCl_4; this reaction was related in a definite way to the hydrogen reduction. X-ray powder diffraction data are given for VOCl and VCl_2. (auth)

10793 PRESSURE-COMPOSITION DATA FOR THE LIQUID HCl–HBr SYSTEM AT DRY-ICE TEMPERATURES. J. D. Corbett and W. J. Burkhard (Ames Lab., Ames, Iowa). J. Inorg. Nuclear Chem., 16: 142-6(1960). (IS-74)

A simple, pressurized thermostat containing solid CO_2 was used to achieve temperatures accurate to <0.01° in the range −78.4 to −79.0°. The vapor-pressure of high-purity HBr in this temperature range is given by log $P_{mm} = -9.5915 \times 10^2/T + 7.5316$. Similar equations are reported for the vapor-pressures of eight mixtures of HCl and HBr and dew point pressures for four. The system shows moderate positive deviation from ideality. (auth)

10794 VAPOUR EQUILIBRIA IN THE B_2O_3–H_2O SYSTEM AT ELEVATED TEMPERATURES. S. P. Randall and J. L. Margrave (Univ. of Wisconsin, Madison). J. Inorg. & Nuclear Chem., 16: 29–35(Nov. 1960). (In English)

The equilibrium pressures of $H_3BO_{3(g)}$, $HBO_{2(g)}$, and $(HBO_2)_{3(g)}$ were determined by a transpiration method in the temperature region 1000 to 1273°K. From these data the calculated heats of formation are $\Delta H_{f\,0°K}\,[HBO_{2(g)}] = -134.9 \pm 1$ kcal/mole and $\Delta H_{f\,0°K}\,[(HBO_2)_{3(g)}] = -537.5 \pm 3$ kcal/mole. (auth)

10795 ON THE OXIDES OF CERIUM. IV. THE OXYGEN DISSOCIATION PRESSURE IN CERIUM OXIDE SYSTEMS. G. Brauer, K. A. Gingerich, and U. Holtschmidt (Universität, Freiburg i. B.). J. Inorg. & Nuclear Chem., 16: 77-86(Nov. 1960). (In German)

Systematic measurements of oxygen dissociation pressure in the system of the cerium oxides from CeO_2 to Ce_2O_3 are reported for 600 to 1050°C, using a dynamic method with given hydrogen–water-vapor mixtures. The oxygen dissociation pressures have values between 10^{-17} and 10^{-33} atm. From these results isotherms of the oxygen dissociation pressure are plotted as log p_{O_2} vs. composition of the solid for 600, 700, 800, 900, and 1000°C. From the shape of these isotherms, conclusions were made with respect to the phase relationships and the heats of formation of the system considered. (auth)

10796 ON THE OXIDES OF CERIUM. V. HIGH-TEMPERATURE-X-RAY DIFFRACTION OF CERIUM OXIDE. G. Brauer and K. A. Gingerich (Universität, Freiburg i. B.). J. Inorg. & Nuclear Chem., 16: 87–99(Nov. 1960). (In German)

Samples of cerium oxide with compositions of $CeO_{2.00}$ to $CeO_{1.78}$ were examined by high-temperature x-ray diffraction between 20 and 1000°C. From these experiments the phase relation in this region is fully explained for the first time. All phase transitions occur very rapidly. The composition of the phase boundaries changes considerably with the temperature; in particular, a miscibility gap, which has the boundaries $CeO_{2.00}$ and $CeO_{1.81}$ at room temperature, contracts with rising temperature and closes at 685°C and at a composition of $CeO_{1.92}$. At higher temperatures a homogeneous series of mixed crystals with cubic fluorite structure exists as is predicted for such a system. A summarizing discussion is given for the system of the cerium

oxides, including the measurements of oxygen dissociation pressure. (auth)

10797 ADSORPTION OF COBALT, ZINC, BARIUM AND CESIUM FROM DILUTE SOLUTIONS. M. H. Kurbatov and O. J. Kvamme (Ohio State Univ., Columbus). J. Inorg. & Nuclear Chem., 16: 109–13(Nov. 1960). (In English)

It is shown that a maximum of 97% of the zinc in a solution containing 8×10^{-8} mole/30 ml can be removed from solution by a single filtration through Schleicher and Schuell Blue Ribbon paper at pH 6.5 when the ammonium salt concentration is 3×10^{-6} M. Under similar conditions 70% of the cobalt present in a solution containing 2.8×10^{-9} mole/30 ml can be removed. Only 43 to 46% of barium and 5 to 6% of cesium are removed from solutions which have 3×10^{-9} mole/30 ml and less than 10^{-8} mole/30 ml, respectively. These results permit the conclusion that unweighable quantities of zinc and cobalt ions in solution with cesium, and probably other alkali-metal salts, can be separated from these salts by adjustment of pH with ammonia and filtering of the solutions. The cobalt and zinc which may be radioactive are recoverable in almost invisible quantities of solid (after ammonium salt sublimation) suitable for nuclear spectroscopy studies or for other use requiring relatively salt-free high-specific-activity tracers. (auth)

10798 A STUDY OF TRANSFERENCE AND SOLVATION PHENOMENA. II. SILVER PERCHLORATE IN WATER, WATER-ETHANOL, AND ETHANOL SOLVENTS. W. Ves Childs and E. S. Amis (Univ. of Arkansas, Fayetteville). J. Inorg. & Nuclear Chem., 16: 114–23(Nov. 1960). (In English)

For water solvent the transference number of silver ion in silver perchlorate decreases slowly but linearly with decreasing concentration of the salt and extrapolates to 0.488 ± 0.005 at infinite dilution. This value agrees quite well with values for dilute solutions recorded in the literature. The moles of water carried per mole of cation increases with decreasing weight per cent silver perchlorate, as is to be expected and is in agreement with the decrease of the transference number with increasing weight per cent ethanol. There was first a small linear decrease of transference number of the silver ion with increasing weight per cent ethanol to about 55 wt.% ethanol. Then there was an accelerated rate of decrease of the transference number up to about 85 wt.% ethanol when the rate of decrease again decelerated. The solvation data indicated that silver ion carries an excess of water compared to the perchlorate ion whereas the perchlorate ion seems to carry alcohol molecules in an amount equal to or greater than the silver ion, depending on how the basis of comparison is determined. These data might be interpreted as showing selective solvation of silver and perchlorate ions by water and ethanol, respectively. (auth)

10799 SOME METAL COMPLEXES OF CITRATE. II. ANION EXCHANGE STUDIES. N. C. Li and J. M. White (Duquesne Univ., Pittsburgh). J. Inorg. & Nuclear Chem., 16: 131–7(Nov. 1960). (In English)

The anion-exchange behavior of Co(II), Zn(II), uranyl, and Th(IV) was studied in citrate solutions with a strong-base anion exchanger. The highest order complex of cobalt, zinc, and thorium with citrate is of the 1:2 type. An anionic thorium-citrate complex is formulated to be $Th(Cit' Cit)^{3-}$. Uranyl forms only a 1:1 complex with citrate. (auth)

10800 SOME STUDIES IN THE INORGANIC CHEMISTRY OF THE REACTION BETWEEN URANYL FLUORIDE AND CHLORINE TRIFLUORIDE. J. F. Ellis and C. W. Forrest (United Kingdom Atomic Energy Authority, Capenhurst, Ches., Eng.). J. Inorg. & Nuclear Chem., 16: 150–3(Nov. 1960). (In English)

A study was made of the reaction between uranyl fluoride and chlorine trifluoride at 50, 100, and 150°C. In the experiments at 100 and 150°C, almost all the chlorine trifluoride reacted in 10 min. At 50°C, only about half the chlorine trifluoride was profitably used after 30 min. The other gaseous reaction products were O_2, Cl_2, ClF, and ClO_2F, with the possibility that ClO_2 acted as a reaction intermediate. The assignation of stoichiometrical equations was complicated by side reactions of the reactive halogen gases both with residual water in the uranyl fluoride and with the walls of the reaction vessel. (M.C.G.)

10801 THE PREPARATION OF ANHYDROUS PLUTONIUM TRICHLORIDE. D. Boreham, J. H. Freeman, E. W. Hooper, I. L. Jenkins, and J. L. Woodhead (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. & Nuclear Chem., 16: 154–6(Nov. 1960). (In English)

Preparation of $PuCl_3$ by chlorination of plutonium dioxide, plutonium(IV) "carbonate," and plutonium(III) and Pu(IV) oxalates with phosgene or hydrogen chloride is described. In the chlorination of plutonium dioxides by phosgene, no reaction took place below 700°C. Small samples (10 to 50 mg) were completely chlorinated at 850°C, but larger (5g) samples were only partly chlorinated since a layer of molten $PuCl_3$ prevented the reaction from going to completion. Complete conversion of plutonium(III) oxalate to $PuCl_3$ with phosgene was obtained in 3 to 4 hr at 600 to 650°C, but the product was contaminated with carbon. Quantitative conversion of the "carbonate" to the trichloride was repeatedly obtained on the 20-g-plutonium scale. In hydrochlorination of plutonium(III) or (IV) oxalate, heating the oxalates at 140°C (in argon) for 1 to 2 hr before introducing hydrogen chloride at 140°C was found desirable. (M.C.G.)

10802 THE THERMAL DECOMPOSITION OF BARIUM PERMANGANATE. E. G. Prout and P. J. Herley (Rhodes Univ., Grahamstown, South Africa). J. Phys. Chem., 65: 208-12(Feb. 1961).

The thermal decomposition of whole and ground crystals of $Ba(MnO_4)_2$ was investigated in the temperature range 140 to 190°C. Activation energies for the acceleratory and decay coefficients were measured. Reaction during the main acceleratory period was presumed to proceed by the mechanism proposed for the decomposition of $KMnO_4$. The decay period followed the unimolecular law. Preirradiation in a γ-ray source accelerated the thermal decomposition and the results are interpreted by a mechanism similar to that suggested for preirradiated $KMnO_4$. (auth)

10803 THE FIRST IONIZATION CONSTANT OF HYDROGEN SULFIDE IN WATER. H. L. Loy and D. M. Himmelblau (Univ. of Texas, Austin). J. Phys. Chem., 65: 264-7(Feb. 1961).

Recent developments in radioactive tracing techniques and the availability of radioactive tracers were exploited, together with standard conductance techniques to determine the thermodynamic first ionization constant of hydrogen sulfide: $K_1 = [(m_{H^+})(m_{HS^-})/(m_{H_2S})][(\gamma_{H^+})(\gamma_{HS^-})/(\gamma_{H_2S})]$. The apparent ionization constant of H_2S was determined at successively lower concentrations of H_2S in the range of 1×10^{-3} to 16×10^{-3} molal, and a true thermodynamic constant evaluated by extrapolation to infinite dilution. Water with a conductivity of 0.25×10^{-6} mho at 25° was obtained by distilling deionized water under a hydrogen atmosphere directly into the reaction flask and proceeding with the experiment as soon as the water reached thermal equilibrium

with the thermostat. The values obtained for the first ionization constant were $0.271 \times 10^{-7} \pm 4\%$, $0.87 \times 10^{-7} \pm 4\%$, and $1.52 \times 10^{-7} \pm 7\%$ at 0, 25, and 50°, respectively. These values are in general agreement with values obtained by previous investigators, taking into account the high ionic strengths employed by them. (auth)

10804 HEATS OF MIXING OF NON-ELECTROLYTE SOLUTIONS. II. PERFLUORO-n-HEPTANE + ISOOCTANE AND PERFLUORO-n-HEXANE + n-HEXANE. A. G. Williamson and R. L. Scott (Univ. of California, Los Angeles). J. Phys. Chem., 65: 275-9(Feb. 1961).

Heats of mixing were measured for the systems perfluoro-n-heptane + isoöctane (2,2,4-trimethylpentane) at 30 and 50° and for the system perfluoro-n-hexane + n-hexane at 25 and 35°. The results are correlated with the excess Gibbs' free energies of mixing measured by other workers. (auth)

10805 ABSORPTION OF DEUTERIUM BY PALLADIUM. Ted B. Flanagan (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 65: 280-4(Feb. 1961).

The course of absorption of deuterium by palladium wire specimens was followed by changes in their electrode potentials and relative resistances in dilute acid solutions. The electrode potential (25°, 1 atm D_2, W.R.T. Pt/D_2) in the region of coexistence of the α and β phases is 31.0 ± 0.5 mv as compared to 50 mv for the palladium–hydrogen system. The rate is constant over the majority of the absorption. An absorption isotherm was constructed from the change of electrode potential with deuterium content of the palladium. The temperature coefficient of the electrode potential was determined in the two-phase region, from which the heat of absorption is calculated as −8795 cal/mole D_2. (auth)

10806 SOLVENT EXTRACTION STUDIES OF INTERHALOGEN COMPOUNDS OF ASTATINE. Evan H. Appelman (Univ. of California, Berkeley). J. Phys. Chem., 65: 325-31(Feb. 1961).

The distribution of astatine between aqueous solutions and CCl_4 was used to study the reactions of this synthetic element with I_2, I^-, IBr, Br^-, and Cl^-. The species AtI, AtBr, AtI_2^-, $AtIBr^-$, $AtICl^-$, $AtBr_2^-$, and $AtCl_2^-$ were characterized, and the equilibrium constants interrelating them were evaluated. These constants were shown to correlate well with the analogous constants involving the lighter halogens. In the course of this investigation the equilibrium constant for the distribution of IBr between water and CCl_4, and the formation constant of IBr_2^- were redetermined, and the results are in substantial agreement with previous work. (auth)

10807 TWO URANYL PEROXIDES. Louis Silverman and Robert A. Sallach (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 65: 370-1(Feb. 1961).

Two different crystalline forms of UO_4 can be precipitated readily. The first is obtained from 1 to 2M UO_2SO_4, pH2, at 80°C, and is a dihydrate. The second is obtained at room temperature in 1 to 2M UO_2SO_4 at pH2, and is a tetrahydrate. The tetrahydrate can be converted to the dihydrate by digestion in water at pH2 at 80°C for 4 hr. X-ray diffraction patterns confirm this. (T.R.H.)

10808 THE KINETIC ISOTOPE EFFECT IN DEUTERIUM- AND TRITIUM-EXCHANGE IN LIQUID AMMONIA. F. S. Yakoushin and A. I. Shatenstein (Karpov Inst. of Physics and Chemistry, [USSR]). Kinetika i Kataliz, 1: 489-95 (1960). (In Russian)

Fluorene labeled with D_2O or HTO (T = tritium) in the methylene group, and methyl-β-naphthylketone labeled with the heavy isotope in the methyl group (0.1 to 0.2 g of material) were mixed with 11 to 13 g of purified liquid NH_3, and held for 1 to 2 hr under pressure at 25°C. The exchange reaction was interrupted by cooling to −78°C and the sample was burned in a current of oxygen. Deuterium was determined by the falling drop method with an accuracy of 1 to 2%, and the H^3 was determined by counting a mixture of hydrogen and tritiated butane at 1 to 4 mm pressure on a SBM-7 or SBC-5 counter with an accuracy of 2 to 3%. Calculation of the first-order reaction rate constants showed that the ratio of the constants for deuterium and H^3 (k_D/k_t) was equal to two for fluorene and methyl-β-napthylketone. In both cases deuterium on the aliphatic group (C-H bonding) exchanged with the hydrogen of liquid NH_3 twice as fast as H^3. It is proposed that the rate of reaction is controlled by bond breakage of the C-H group of an intermediate activated complex. 35 references are given. (TTT)

10809 KINETICS OF ISOTOPE EXCHANGE OF MOLECULAR OXYGEN WITH OXIDE SURFACES OF IRON, COBALT, NICKEL, AND COPPER. V. V. Popvskil and G. K. Boreskov (Karpov Inst. of Physics and Chemistry, [USSR]). Kinetika i Kataliz, 1: 566-75(1960). (In Russian)

Oxygen containing 4 at.% O^{18} was circulated at a rate of 600 l/hr over Fe_2O_3, Co_3O_4, NiO, and CuO in a system with a volume of 1:1. Samples were periodically withdrawn for analysis on a mass spectrometer. The rate of exchange was studied at temperatures of 150 to 400°C, oxygen pressures of 10 and 30 mm Hg, and for various compositions and treatments of the solid oxide An analysis of the data shows that the surface of Fe_2O_3 omogeneous, but that the surfaces of Co_3O_4, NiO, and CuO are not homogeneous. The average rates of exchange at 200°C and an oxygen pressure of 10 mm are 7.2×10^{22} for Co_3O_4, 3.4×10^{19} for NiO, 2.0×10^{18} for CuO, and 8.7×10^{14} for Fe_2O_3 in $l/m^2/hr$. The rate of oxygen exchange is apparently determined by the concentration of oxygen adsorbed on the surface of the catalyst. (TTT)

10810 THE CONVERSION OF ORTHO-HYDROGEN TO PARA-HYDROGEN ON SOLID CATALYSTS AT TEMPERATURES OF 64 TO 78°K. R. A. Buyanov (Joint Inst. for Nuclear Research, Dubna, USSR). Kinetika i Kataliz, 1: No. 2, 306-12(July–Aug. 1960). (In Russian).

In storing liquid hydrogen for a prolonged period of time it is desirable to convert the ortho form to the para form, because this reaction goes spontaneously at low temperatures with the evolution of a considerable amount of heat as follows: $O\text{-}H_2 \rightarrow p\text{-}H_2 + 340$ cal/mol. The conversion rate should be proportional to the square of the effective magnetic moment μ_{ef}: $\mu_{ef} = 2\sqrt{s(s+1)} = \sqrt{n(n+2)}$, where S is the resulting spin moment of the catalyst and n is the number of unpaired electrons of the catalyst. $Cr(OH)_3$, $Mn(OH)_4$, $Fe(OH)_3$, and $Ni(OH)_3$, prepared by slow precipitation of the hydroxide gel from dilute solutions and drying at 100 to 135°C for 24 hr, were found to be effective catalysts. The value of $k/\mu_{ef}^2 \times 10^5$ was found to be relatively constant (4.5 to 8.0) at a temperature of 64 to 78°K, where k is the reaction rate constant in $mol\text{-}cm^{-3}\text{-}sec^{-1}$. The optimum grain size is 0.7 to 0.98 mm. The reaction rate constant was determined as a function of pressure from 50 mm Hg to 150 atm. The cost of the catalysts is low, and they are stable in operation. (TTT)

10811 BEHAVIOR OF RHODIUM(III) TOWARDS ION EXCHANGE RESINS. Hikaru Shimojiwa (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 564-7(Apr. 1960). (In Japanese)

The K_d values of Rh(III) in the Rh(III)-HCl system were determined with the batch method using Rh^{102} as the tracer.

Results with the anion exchange resins Dowex 1-X8 and 1-X4 and the cation exchange resins Dowex 50W-X8 and 50-X4 were described. Rh(III) was not appreciably adsorbed on the cation exchange resins in 0.1 to 12N HCl. Rh(III) was not adsorbed on the anion exchange resins in 3 to 12N HCl but adsorbed to some extent in the concentration range of HCl lower than 3N. When the carrier-free Rh-102(III) solution was passed through either anion or cation exchange resin column, a part of Rh(III) was adsorbed quite strongly, and very slightly recovered. Many chemicals were tested for recovering strongly adsorbed Rh(III). It was found that the best way to recover adsorbed Rh-102(III) was to keep it boiling with 6N HCl for many hours. (auth)

10812 REACTION OF ZIRCONIUM HYDRIDE WITH CARBON TETRACHLORIDE. Takuya Hata (Mitsubishi Electric Mfg. Co., Ltd., Amagasakishi, Japan) and Tatsuo Maekawa. Nippon Kagaku Zasshi, 81: 677(Apr. 1960). (In Japanese)

The reaction of ZrH_2 with CCl_4 was studied over the temperature range from room temperature to 250°C. Below the boiling point of CCl_4 the reaction products were $ZrCl_4$ and C_2Cl_6, but above the boiling point they were $ZrCl_4$ and carbon. (auth)

10813 ON SULFATE COMPLEXES OF URANIUM(VI). Shigeki Matsuo (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 81: 833-6(June 1960). (In Japanese)

The formation constants and the absorption spectra of uranyl sulfate complexes were investigated spectrophotometrically. The measurements were performed at 25°C, and the ionic strength remained constant at 1.00 with sodium perchlorate. The formation constants of 1:1 and 1:2 complexes were evaluated to be 65 ± 2 and 3 ± 0.4, respectively. The values obtained by Ahrland were in accordance with the present values substantially. The absorption bands of sulfate complexes shifted to longer wavelengths with increasing number of complexed sulfate ions, but the spectra of the sulfate complexes were observed to be similar to that of the uranyl ion. (auth)

10814 A STUDY ON THE RADIOACTIVE DECONTAMINATION. THE EFFECTS OF CONDENSED PHOSPHATES ON THE RADIOACTIVE DECONTAMINATION OF VARIOUS METAL SURFACES. Yuzo Tajima and Yoshiki Wadachi (Atomic Energy Research Inst., Ibaraki, Japan). Nippon Kagaku Zasshi, 81: 891-5(June 1960). (In Japanese)

In order to study the radioactive decontamination of various metal surfaces such as iron, stainless steel, copper, brass, lead, and aluminum, they were first contaminated with Co^{60} and with fission products. Using a standard test washing machine, these contaminated surfaces were rinsed with aqueous solutions of condensed phosphates. At the same time, the relationships between pH and complex-forming abilities of the condensed phosphates were measured for $CoCl_2$ and fission products. The results obtained both for the decontamination and complex formation measurements indicated the suitable condition for decontamination of the metal surfaces by the condensed phosphates. The suitable decontamination procedure is offered as follows: condensed phosphates; 0.1 to 0.01 mole/l, temperature; 30°C, acidity; pH 3 to 6. In this temperature, these condensed phosphates are not suffered from decomposition, moreover, general metal surfaces may be uncorrosive at this acidity. (auth)

10815 DECARBOXYLATION OF CARBOXYLIC ACID SALTS. I. ISOTOPIC TRACER STUDIES ON THE PYROLYSIS OF THORIUM CARBOXYLATES. Masao Okubo and Ryozo Goto (Kyoto Univ.). Nippon Kagaku Zasshi, 81: 1132-6(July 1960). (In Japanese)

The relative ease of ketonic decarboxylation of thorium carboxylates, $R(COO)_4Th$, was determined by the C^{14} isotopic labeling method, and their decomposition temperature was determined by the manometric method. Satisfactory agreement was obtained between the results of isotopic and manometric methods, except for thorium formate. The order of the ease of decarboxylation of $R(COO)_4Th$ is as follows: R-: $C_6H_5CH_{2-}$, CH_{3-}, $CH_3CH_2 \cdot CH_{2-}$, $(CH_3)_2CH-$, C_6H_{5-}, and $(CH_3)_3C-$. The order is the same as that of the relative rates of the alkaline hydrolysis of the same carboxylic acid ethyl esters. (auth)

10816 DEHYDRATION AND DISSOCIATION OF ZIRCONIUM HYDROXIDE AND HAFNIUM HYDROXIDE. Sadashige Takagi (Osaka Univ.). Nippon Kagaku Zasshi, 81: 1531-2 (Oct. 1960). (In Japanese)

The behavior of hafnium hydroxide in dehydration and pyrolysis was examined and compared with zirconium hydroxide. The end products of dehydration of both compounds at room temperature are $M(OH)_4 + 2H_2O$ in the air, $M(OH)_4$ over calcium chloride, and $MO_2 + 1.5H_2O$ over concentrated sulfuric acid (M is zirconium or hafnium). The curves of pyrolysis of both compounds containing considerable amount of water are similar, having the breaks corresponding to the composition $MO(OH)_2$ at ~140° (zirconium) and 155° (hafnium). The breaks, however, disappear when dried hydroxides are used. (auth)

10817 THE DEUTERATION OF SOME CYCLIC OLEFINS ON IRON AND OTHER TRANSITION METAL FILMS. J. Erkelens, A. K. Galwey, and C. Kemball (Queen's Univ., Belfast). Proc. Roy. Soc. (London), A260: 273-92(Feb. 21, 1961).

The products formed by the deuteration of cyclohexene on films of nickel, palladium, platinum, and tungsten at −35 and 0°C were determined by means of a mass spectrometer. Studies over a greater range of temperatures were made with cyclopentene, cycloheptene, norbornylene, 4-methylmethylenecyclohexane and 4-methylcyclohexene on iron films. At low temperatures the deuteration of the unsubstituted olefins yielded products mainly in the range d_0-cyclo-alkane to d_n-cyclo-alkane (n representing the number of carbon atoms in the molecule). Evidence was obtained that these patterns of products were caused by the interconversion, on the surface, of adsorbed cyclo-alkene molecules and cyclo-alkyl radicals. The shape of these adsorbed species restricted the formation of more highly deuterated alkanes, although some of these were formed by the deuteration of deutero-olefins produced during the course of the reactions. A second type of reaction, producing cyclo-alkanes in the range d_{n+1} to d_{2n} and extensive exchange of the deuterium, occurred with iron films at higher temperatures. The additional activation energy required for this reaction was about 4 to 5 kcal/mole with the C_5, C_6, and C_7 olefins. The possible adsorbed intermediates involved in the reaction are discussed. Sintering of the iron films markedly reduced the amount of this second type of reaction. Various interesting features in the patterns of products from the deuteration of the other olefins on iron are reported and discussed. A preliminary investigation was made on the deuteration of 1,4-cyclohexadiene and cyclopentadiene on iron films and yielded results that were entirely consistent with the proposed mechanism for the deuteration of the olefins. (auth)

10818 NEPTUNIUM (IV) AND (VI) PHENYLARSONATES. P. I. Kondratov and A. D. Gel'man. Radiokhimiya, 2: 659-62(1960). (In Russian)

Reactions of Np(IV) and (VI) with phenylarsonic acids were analyzed by precipitating Np with 4% aqueous solutions.

Preliminary results indicate that Np(IV) and (VI) form compounds resistant to solubility and Np(V) does not precipitate with phenylarsonic acid. The solubility products of neptunium phenylarsonates of Np(IV) and Np(VI) are $NpR_2 = (2.7 \pm 2.5) \times 10^{-30}$ and $NpO_2R = (1 \pm 0.2) \times 10^{-14}$ respectively. (R.V.J.)

10819 PREPARATION, COMPOSITION AND PROPERTIES OF URANYL DIETHYLDITHIOCARBAMATE COMPLEXES. Ya. I Zil'berman and B. I. Peshchevitskiĭ. Radiokhimiya, 2: 663-7(1960). (In Russian)

A convenient method of preparing sodium uranyl tricarbamate is suggested. The uranyl tricarbamates of rubidium, cesium, calcium, strontium, barium, and ammonium were separated, and the properties of various uranyl diethyldithiocarbamate derivatives were analyzed. (R.V.J.)

10820 KINETIC AND EQUILIBRIUM STUDIES OF REDOX REACTIONS IN LIQUID BISMUTH. D. G. Schweitzer and D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). Trans. Met. Soc. AIME, 221: No. 1, 192-8(Feb. 1961).

The empirical equilibrium constants ($\bar{K} = C_U/(C_{Mg})^2$) and the heat of reaction for the reduction $2Mg_{(Bi)} + UO_{2(S)} \rightleftharpoons 2MgO_{(S)} + U_{(Bi)}$ were determined from 300 to 500°C. The mechanisms of the oxidation of uranium and magnesium from dilute bismuth solutions were investigated. The kinetics of some of the reactions were affected by air adsorbed on the uranium oxides. (auth)

10821 A FLOTATION METHOD FOR STUDYING THE RUBIDIUM ADMIXTURE EFFECT ON THE DENSITY OF KCl CRYSTALS AND THE DETERMINATION OF THE RUBIDIUM CONTENT IN POTASSIUM SALTS. V. S. Rylov (Engineering-Physics Inst., Academy of Sciences, Leningrad). Zhur. Anal. Khim., 16: 14-20(Jan.-Feb. 1961). (In Russian)

The flotation method was used for investigating the effect of RbCl impurities on the density of KCl crystals. It was found that this method can be applied to investigate the distribution of an impurity between the molten salt and its crystal phase. In KCl the distribution coefficient for RbCl depends on the rubidium concentration and approximates to $\alpha = 1$ for small concentrations of RbCl. The density of KCl is a linear function of the RbCl concentration. The flotation method was used for the determination of Rb in KCl in the concentration range 5.0 to 0.001 at.%. (auth)

10822 HEAT OF ZIRCONIUM HALIDE INTERACTIONS WITH ETHERS. O. A. Osipov and Yu. B. Kletenik. Zhur. Neorg. Khim., 5: 2220-2(Oct. 1960). (In Russian)

The heats of formation of molecular zirconium chloride and bromide 1:1 and 1:2 compounds with ethyl formate, ethyl acetate, and ethyl butyrate were determined, as well as the heat of zirconium iodide dissolution in ethylacetate. The attachment heat of the first ether molecule exceeds by several fold the heat required for the annexation of the second molecule. The experiments indicated no regular reduction in the heat of interaction for the zirconium bromide–chloride–iodide series with complex ethers. (R.V.J.)

10823 SECOND CHAPTER OF THE CRYSTAL CHEMISTRY OF SILICATES. N. V. Belov (Crystallographic Inst., Academy of Sciences, USSR). Zhur. Strukt. Khim., 1: No. 1, 39-50(May-June 1960). (In Russian)

During the 1930's the effect of small cations on the crystal chemistry of silicates was studied, whereas current work is directed mostly toward the study of large cations. It has been established that such large cations play a more important role in defining the structure of the silicates than the silicic acid radicals because their radius determines the dimensions of the octahedral unit to which the Si–O tetrahedral must be adapted. Silicates containing Zr, Ti, Ta, and Mn are discussed from the viewpoint of their effect on the rigid structure of the crystals formed. Condensation of Si–O chains into rings results in the formation of xonolite type materials with cementing properties. Their decomposition leads to the formation of the simple wollastonite type structure with loss of cementing strength. Quite surprisingly, lithium silicates also belong to this group since the lithium is able to be placed at the center of the tetrahedron like silicon, whereas in other cases it behaves like its neighbors in the periodic system, beryllium or boron. (TTT)

10824 ADVANCES IN FLUORINE CHEMISTRY. VOLUME 1. M. Stacey, J. C. Tatlow, and A. G. Sharpe, eds. New York, Academic Press, Inc., 1960. 207p.

Fundamental advances in all major branches of the field of fluorine chemistry and developments in the industrial field are reported. Topics covered include: the preparation and uses of halogen fluorides in organic chemistry, transition metal fluorides and their complexes, fluoroboric acids and their derivatives, synthesis of fluoro-organic compounds by the electrochemical process, and exhaustive fluorinations of organic compounds with high-valency metallic fluorides. (M.C.G.)

10825 THE THEORETICAL CALCULATION OF THE HEAT OF ADSORPTION FOR GASES PHYSICALLY ADSORBED ON CARBON SURFACES. E. L. Pace (Western Reserve Univ., Cleveland). p.35-45 of Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

The results of theoretical computations of the differential heat of adsorption for the low boiling gases, nitrogen, argon, neon, orthodeuterium, parahydrogen, and helium (He^4), adsorbed on a graphite surface are compared with the experimental values which were observed for these gases adsorbed on finely divided graphitic surfaces. The role of the zero-point energy in the heat of adsorption is discussed. In the case of parahydrogen and orthodeuterium, the difference in the zero-point energies arising from the difference in masses, accounts satisfactorily for the higher heat of adsorption observed for orthodeuterium. The effect of energy barriers in the surface on the heat of adsorption is considered. For the particular case of a graphitic surface, it is shown that the energy barriers are small, and therefore, a "liquidlike" behavior is reasonable for the adsorbed layers. With this behavior as a basis, an application of simple lattice-liquid theory for characterizing the differential heat of adsorption on a graphitic surface for surface coverage to approximately two monolayers is carried out. (auth)

10826 2-4-10-12-TETRAMETHYL 6-8 DI-ISOBUTYL 7-AZA-6-TRIDECENE AND ITS METHOD OF MANUFACTURE. (to Commissariat à l'Énergie Atomique). British Patent 860,636. Feb. 8, 1961.

A method is given for manufacturing 2,4,10,12-tetramethyl-6,8-diisobutyl-7-aza-6-tridecene which can be hydrogenated according to Patent No. 860,637 to the corresponding tridecane, a useful anion exchanging liquid. In this method, a mixture of 1 mole 2,6,8-trimethyl-4-nonylamine and 1.5 to 2 moles 2,6,8-trimethyl-4-nonanone is heated under ordinary pressure to or near 218 to 220°C. The vapors are condensed, the water is decanted from the condensate, and the organic layer is returned to the boiler until 1 mole water is eliminated per 1 mole amine used. The unreacted reactants are distilled off, and then the 7-aza-6-tridecene is distilled. Some of its physical and optical properties are given. (D.L.C.)

10827 IMPROVEMENTS IN THE MANUFACTURE AND PURIFICATION OF 2-4-10-12 TETRAMETHYL 6-8-DI-ISOBUTYL 7-AZA 6-TRIDECANE. (to Commissariat à l'Énergie Atomique). British Patent 860,637. Feb. 8, 1961.

A method is given for preparing 2,4,10,12-tetramethyl-6,8-diisobutyl-7-aza tridecane, a useful anion exchanging liquid, from the corresponding ketimine (the 7-aza-6-tridecene) manufactured according to Patent No. 860,636. In this method, the tridecene is hydrogenated in the presence of Raney's nickel at 150 to 170°C and the tridecane product distilled off with steam. (D.L.C.)

Analytical Procedures

10828 (AERE-R-3037) A POSSIBLE GALVANIC CELL METHOD FOR MONITORING THE ACTIVITY OF OXYGEN IN A HOT-TRAPPED SODIUM COOLANT CIRCUIT. G. W. Horsley (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1959. 15p.

A hypothetical cell: Na(saturated with Na_2O)/anionic($O^=$) electrolyte/Na(unsaturated with Na_2O), is examined from the theoretical standpoint assuming that the activity of dissolved oxygen in sodium is proportional to its concentration. Provided that it is thermodynamically reversible, such a cell should give for example at 500°C changes in emf for changes in oxygen concentration from 1 to 2 ppm and 9 to 10 ppm, of ≈23 and ≈3 mv, respectively. Furthermore fluctuations in temperature of ±10°C at 500°C would in the concentration range 1 to 10 ppm cause errors of about ±12% in the concentration deduced from the cell voltage. The practical possibilities of building such a cell and incorporating it in a sodium coolant circuit as a monitor are discussed. (auth)

10829 (AERE-R-3432) THE ABSORPTION SPECTRUM OF NITROUS ACID IN TRIBUTYL PHOSPHATE AND ITS APPLICATION TO ANALYSES FOR NITROUS ACID. J. Woodhead (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 10p.

Nitrous acid is extracted readily by tributyl phosphate from aqueous acidic solutions owing to the formation of the complex [$HNO_2 \cdot$ TBP]. The absorption spectrum of this complex has five sharp peaks between 320 and 400 mμ and provides a sensitive method for the estimation of nitrous acid at concentrations down to 5×10^{-4} M in aqueous phases. (auth)

10830 (BM-RI-5727) RAPID DETERMINATION OF ALUMINUM, IRON, COPPER, CADMIUM, AND LEAD IN ZINC-BASE ALLOYS. R. J. Gajan and D. M. Geehan (Bureau of Mines, Washington, D. C.). 1961. 13p.

A fast method was developed for determining Al, Fe, Cu, Cd, and Pb in zinc-base alloys. An adaptation of a photometric method for aluminum was used in which the aluminum is completed with aluminon, forming a red lake. A spectrophotometric method was used for iron in which o-phenanthroline forms a colored complex. Copper, cadmium, and lead were determined polarographically. (J.R.D.)

10831 (CEND/2401/TP-40) THE DETERMINATION OF CARBON IN ZIRCONIUM AND ITS ALLOYS. R. F. O'Connell (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Aug. 18, 1960. 5p.

The sample to be analyzed is heated in an induction furnace. A stream of oxygen converts the carbon to carbon dioxide and the gas is absorbed by dilute sodium hydroxide. The change in conductance of the sodium hydroxide solution is related to the concentration of carbon by reference to a standard curve. (auth)

10832 (CF-60-11-124) RADIOACTIVATION ANALYSIS. G. W. Leddicotte (Oak Ridge National Lab., Tenn.). Nov. 30, 1960. 44p.

Radioactivation analysis is one in which an activation by a nuclear reaction is used to produce a radioisotope of the element. Since this radioisotope decays with characteristic radiations and half life, it is possible to make radioactivation analysis a very specific analysis. Chemical separations of the radioisotope are employed whenever necessary and its activity is measured by a radiation counter. Nuclear reactions involving particle sources of α's, deuterons, γ's, neutrons, and photons can be used in radioactivation analysis. The neutron reactions were used most often in activation analysis. The most useful neutron reaction (n,γ) involves the capture of a neutron by a stable nucleus to produce a radioisotope of the original atom. Since nuclear reactors are prolific sources of (n,γ) reactions, it was possible to use activation analysis in many applications requiring an analytical method of great sensitivity and specificity. Techniques used in radioactivation analyses are described and the limits of measurement and general applications of the method are discussed. 54 references. (auth)

10833 (IGO-AM/S-150(2nd. ed.)) THE DETERMINATION OF FREE CARBON IN BERYLLIUM METAL (BY IGNITION WITH A GASOMETRIC FINISH). (United Kingdom Atomic Energy Authority. Industrial Group. Springfields Works, Springfields, Lancs, England). Mar. 3, 1959. Amended July 1960. 10p.

The beryllium sample is dissolved in sulfuric acid. The solution is filtered and the residue is washed, dried, and ignited in a stream of oxygen. The carbon dioxide produced is measured gasometrically. (auth)

10834 (NAA-SR-4356) METHODS FOR ANALYSIS OF POLYPHENYL REACTOR COOLANTS. R. T. Keen, R. A. Baxter, L. J. Miller, R. C. Shepard, and M. A. Rotheram (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 30, 1961. Contract AT(11-1)-GEN-8. 56p.

Analytical methods developed for the study of irradiated and unirradiated polyphenyl reactor coolants are explained in detail. Gas chromatographic methods are described for the determinations of biphenyl, o-, m-, and p-terphenyl, benzene, toluene, and ethylbenzene in irradiated polyphenyl coolants. Other low-boiling components are also determined collectively by a gas chromatography method. An ultraviolet spectroscopic method is given for the determination of triphenylene (a radiolytic decomposition product of terphenyls). A low-voltage mass spectroscopic technique is described for a "group-type" analysis of the higher boiling decomposition products of polyphenyl coolants. Masses are assigned to phenyl-, alkyl-, and hydro-derivatives of polyphenyls, triphenylenes, and phenanthrenes. Methods are also reported for the determination of gross properties such as high-boiler content of coolants, average molecular weight, carbon and hydrogen content, and olefin (unsaturation) content by ozone absorption. (auth)

10835 (NDA-2154-3) DEVELOPMENT OF A HIGH SENSITIVITY ANALYTICAL METHOD FOR OXYGEN IN SODIUM METAL. Quarterly Progress Report for the Period October 1, 1960 to December 31, 1960. H. Steinmetz (Nuclear Development Corp. of America, White Plains, N. Y.). Mar. 1, 1961. Contract AT(30-1)-2303(XV) Scope 2. 12p.

The experimental apparatus was completely assembled. The design of the apparatus was described in the previous

quarterly report. All components were tested and found to be operating satisfactorily. The gas handling system for preparing standard oxygen in sodium samples was calibrated. In addition, the necessary reagents and solvents were prepared, purified, and standardized. Tests show that traces of zirconium or zirconium oxide do not interfere with the analytical procedure. (For preceding period see NDA-2154-2.) (auth)

10836 (NP-9726) RAPID DETECTION OF URANIUM TRACERS IN THE PRESENCE OF IRON AND COPPER. Report No. 179/IV. K. Majchrzak (Polish Academy of Science. Inst. of Nuclear Research. Warsaw). Oct. 1960. 4p.

A spot test for uranium in solutions containing iron and copper is described. A sulfate-uranyl complex is adsorbed on a strongly basic anion exchanger on which the color reaction of the uranyl ion with potassium ferrocyanide is observed. (J.R.D.)

10837 (NP-9854) THE DETERMINATION OF TOTAL RARE EARTHS IN HIGH GRADE URANIUM PRODUCTS. R. J. Guest (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Aug. 1960. 26p.

Available as Can. Dept. Mines and Tech. Surveys, Mines Branch Research Rept. R 67. $0.25.

A procedure is described for the determination of total rare-earth oxides in high-grade uranium products, based on the use of solvent extraction with long-chain alkyl amines. Extraction with tri-isooctylamine from a strong hydrochloric acid medium removes uranium, zirconium, and a number of other ions. This is followed by a second extraction from sulfate solution, employing di(tridecyl P) amine to remove thorium. Following further conventional purification steps, mixed rare-earth oxides are determined by ignition to the oxides or by a suitable colorimetric method. To establish the completeness of the separations, extraction coefficients for tri-isooctylamine were determined for rare earths, uranium, zirconium, titanium, and thorium in hydrochloric acid solutions of various strengths. The extent of rare-earth pick-up by di(tridecyl P) amine and tri-isooctylamine from sulfate solutions at various pH values is also shown. Application of the procedure to synthetic high-grade uranium samples and actual high-grade uranium products indicates that reliable analyses can be obtained on a variety of sample material. (auth)

10838 (NS-9) THE MEASUREMENT OF RADIO-CAESIUM, STRONTIUM AND BARIUM IN RAINWATER. G. S. McNaughton and R. N. Woodward (New Zealand. Dept. of Scientific and Industrial Research. Div. of Nuclear Sciences, Lower Hutt). Feb. 24, 1960. 27p.

A method is described which was found suitable for the routine measurement of Cs^{137}, Sr^{90}, and Ba^{140} in rainwater. Carrier solutions were added to a collection tank and radionuclides in the rainwater were subsequently absorbed at 80°C on a Dowex 50 ion exchange column. Cesium, strontium, and barium fractions were obtained by successive elutions with 0.7M HCl, 1.5M ammonium lactate pH 7.0, and 4M HCl. The cesium fraction was further radiochemically purified, the carrier recovery for cesium determined by flame photometry, and the activity counted in a γ spectrometer. The strontium and barium fractions were separately reabsorbed on smaller resin columns, and the daughters Y^{90} and La^{140} eluted, precipitated, weighed as oxalates, and counted in a low-background β counter. (auth)

10839 (ORNL-3060) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1960. (Oak Ridge National Lab., Tenn.). Feb. 15, 1961. Contract W-7405-eng-26. 134p.

Analytical Instrumentation (X-10). Work was continued on in-line instrumentation. Gamma-absorptiometric techniques for the continuous determination of heavy elements in flowing streams were studied. A plant type α-detecting instrument, designed to monitor for excessive product losses in chemical-processing waste streams was found to have sufficient sensitivity for the streams being considered at present. An absorption-cell attachment for a Welch Densichron reflection unit was designed and fabricated so that either reflectance or absorbance measurements can be made remotely. An automatic-fill circuit and a plunger-position indicator were added to the control unit for the remotely servo-controlled pipetter. Development has continued of a high-resolution high-sensitivity, scanning, recording flame spectrophotometer. A corrosion-resistant pipet was designed and tested, and one was installed in a remotely servo-operated pipetter in the High-radiation-level Analytical Facility. The performance of the ORNL controlled-potential a-c polarograph was studied. Circuitry for counting drops from and measuring the rate of flow of mercury through a D.M.E. was designed and built. Derivative polarography provides a rapid, easy, and accurate means of determining n values. A standard addition method for the mathematical analysis of interfering derivative waves was developed; the method makes possible the correct measurement from interfering derivative waves of concentrations of the reducible species. Ionic Analyses (X-10). Continued work in electrochemistry, titrimetry, spectrophotometry, and gas chromatography is reported. The technique of generation and back-titration of intermediate reagents by means of controlled-potential coulometry was studied. A method for the coulometric titration of uranium(IV) was investigated. A study was made of the chemical reaction between Purex waste solutions and sodium chloride. A method was developed for the titrimetric analysis of mixtures of monobutyl-, dibutyl-, and orthophosphoric acids. Spectrophotometric techniques are being developed for the fundamental study, at high temperatures and pressures, of aqueous solutions of interest in high-temperature chemistry and in reactor technology. An ultraviolet–visible–near-infrared spectrophotometer, designed to be operated at temperatures as high as 330°C and pressures of at least 3000 psi in the presence of high levels of α radiation, is being designed. A mathematical technique that uses high-speed digital computation was developed to resolve seriously overlapping spectral bands and fine structure. The gas chromatographic work was concerned with the analysis of gases from off-gases of dissolvers and of HRT shield gas, with studies of the recombination of deuterium and oxygen in thoria slurries and with studies of radiolytic decomposition of water. Nuclear Analyses (X-10). Trace and macro quantities of many elements were determined in many types of materials by neutron-activation analysis; a summary of these applications is presented. In addition, other nuclear techniques, for example, neutron absorption, neutron transmission, and delayed-neutron counting, have been used to determine concentrations of elements. A low-level gamma spectrometer was developed. Optical and Electron Microscopy (X-10). Particles of many types of materials were studied to determine their size, shape, and surface characteristics. A variety of metals and ceramics that had been reactor exposed was examined to determine the chemical and physical nature of the surface layers. Metals and thin films of interest in corrosion studies were also investigated. Radiochemical Analyses (X-10). The γ branching of Kr^{85} was determined, and work on the decay scheme of Pm^{148} was completed. Neutron-capture cross sections for Os^{184}, Cd^{108}, and Au^{197} were determined. Gas chromatography has been ap-

plied in the separation of the fission gases krypton and xenon. New developments in solvent-extraction techniques include the separations of lanthanides and actinides, use of organophosphorus compounds, and preparation of a monograph on extractions with amines. Reactor Projects Laboratory (Y-12). Research was continued in the investigation of the absorption spectra of various molten-fluoride systems by use of the pendent-drop technique for confining the molten salts The spectra of the fluorides of praseodymium, neodymium, and samarium dissolved in molten lithium fluoride were obtained and compared with their spectra in aqueous and nonaqueous solvents. The investigation and evaluation of chromogenic reagents for use in molten-salt media were extended to sulfonate derivatives of phthalocyanine. Solvent-extraction studies with organophosphorus compounds, primarily tris(2-ethylhexyl)phosphine oxide, were continued. An improved procedure was established for the determination of thorium and uranium in granite and other siliceous rocks. The high-temperature fluorination technique, using potassium tetrafluorobromide for the determination of oxygen in metals and fluoride salts, was extended to the determination of oxygen in Be, Dy, Si, Nb, and Mo. A gas chromatographic method for the determination of oxygen released during the irradiation of alkali-metal bromates was developed. The Leco automatic sulfur titrator was modified to make possible the determination of as little as 0 to 10 μg of sulfur in test portions of various metals. A simple rapid method was devised to determine boron trifluoride in helium; it is based on the reaction of boron trifluoride with calcium chloride. Spectrochemical and X-Ray Analyses (X-10 and Y-12). Chemical methods were developed for dissolving high-fired beryllium oxide and for isolating traces of silicon from copper and traces of rare earths for spectrochemical determination. It was found that the loss of boron during the evaporation of hydrochloric acid and hydrochloric-hydrofluoric acid solutions of boric acid is prevented by the presence of excess mannitol. The x-ray absorption-edge method has been extended to include Zr, Mo, Hf, and Sn. A new method of pulverizing dried tissue has been proved to be successful, and the container-cleaning procedure was shown not to cause cross-contamination. An analog computer was designed and built that will automatically calculate and print out analytical results from data produced by a direct-reading spectrometer. Thermal Breeder Reactor Projects Analytical Chemistry Laboratory (Y-12). The major portion of the work of the Thermal Breeder Reactor Projects Analytical Chemistry Laboratory is the analysis of solutions of thorium oxide, uranyl sulfate, mixtures of other metallic oxides, and a number of additives and/or corrosion products of materials used in reactor tests. Studies have been continued in order to develop or improve methods for these analyses. (For preceding period see ORNL-2866.) (auth)

10840 (PG-Report-57) ANALYTICAL METHOD FOR THE RAPID ESTIMATION OF URANIUM IN URINE USING THE TYPE 1080A FLUORIMETER. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1960. 10p.

The inorganic residue remaining after the evaporation and ignition of 1 ml urine is fused with a sodium fluoride–sodium bicarbonate fusion mixture. The fluorescence of melt is measured in a type 1080A fluorimeter, and the uranium content is assessed by applying a factor obtained from a calibration using external standards or from the readings obtained by the addition of an internal standard to the sample. (auth)

10841 (PG-Report-114) ANALYTICAL METHODS FOR THE INSPECTION OF CALCIUM FLUORIDE. (United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb, England). 1960. 18p.

The calcium, carbonate, and sulfate contents and the ignition loss are determined gravimetrically. Chromium, iron, and silicon are determined colorimetrically and the chloride is estimated turbidimetrically. The material is graded by sieving. (auth)

10842 (PG-Report-143) ANALYTICAL METHOD FOR THE FLUORIMETRIC DETERMINATION OF URANIUM IN BIOLOGICAL MATERIAL. (United Kingdom Atomic Energy Authority. Production Group. Springfields, Lancs, England). 1960. 12p.

After preliminary preparation, the sample solution is evaporated, and the residue is ignited. Uranium is extracted from a nitric acid solution of the ignited material and determined fluorimetrically. (auth)

10843 (RICC-283) ACTIVATION ANALYSIS UTILIZING FAST RADIOCHEMICAL SEPARATIONS AND PORTABLE NEUTRON GENERATORS. W. Wayne Meinke (Michigan. Univ., Ann Arbor. Dept. of Chemistry.). 28p.

A general discussion is presented on the use of activation analysis. With the equipment and techniques described, activation analyses were made on U, Ag, Rh, Cu, Co, Tl, Nb, and Ti. (W.L.H.)

10844 (TID-5879) BIBLIOGRAPHY ON THE DETERMINATION OF RADIOACTIVE THALLIUM AND RHODIUM. Laboratory Report 57-5. Ira B. Whitney (New York Operations Office. Health and Safety Lab., AEC). Nov. 20, 1957. 17p.

Ninety-nine titles, presented alphabetically by senior author, which comprise the analytical methods for rhodium and thallium as abstracted in Chemical Abstracts from 1951 to date, are included. Several standard texts are also included. (W.L.H.)

10845 (Y-1324) ANALYTICAL METHODS IN THE BERYLLIUM PROGRAM. J. M. Googin (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Dec. 13, 1960. 12p. Contract W-7405-eng-26.

The dependency of the physical-metallurgical properties of beryllium on the purity of the metal has dictated a rather complete characterization of the metal purity. Direct assay of the beryllium content of the metal can provide only a rough indication of the over-all purity due to the limitations of existing methodology. Spectrography of trace impurities in beryllium or beryllium oxide has extended to account for some 58 elements. Additional analytical methods were developed and/or evaluated for the determination of beryllium oxide, beryllium nitride, beryllium carbide, iron, thorium, and uranium. The status of these methods is discussed along with some experimental methods which show promise. An instantaneous beryllium air monitor and an automatic spectrograph for trace beryllium analysis are discussed in relation to the health hazards associated with beryllium. (auth)

10846 (AEC-tr-4429) OXIDATIONS WITH PERIODATES. I. DETERMINATION OF SERINE AND THREONINE BY THE ALDEHYDES AND AMMONIA FORMED IN THEIR OXIDATION WITH PERIODATES. Laszlo Maros, Perl (Ibolya Molnar), and Elemer Schulek. Translated from Magyar Kem. Folyoirat, 66: 321-4(1960). 9p.

A method is described for measuring the aldehydes and ammonia formed in the oxidation of serine and threonine with periodates. The serine or threonine is oxidized first in a basic and then in an acetic acid solution for about 60 min in the course of the determination by formaldehyde or acetaldehyde, respectively. Under these circumstances the glyoxylic acid, formed among the first products of the re-

action, is oxidized to carbon dioxide and formic acid. Measurement of the formaldehyde and acetaldehyde can then be carried out directly by the bisulfite–cyanide method. A method involving distillation is used to measure the ammonia. Distillation was carried out from a solution containing sodium sulfite to eliminate the disturbing effect of aldehydes. Serine and threonine may also be determined by measuring excess periodate. (auth)

10847 (CEA-tr-R-564) DOSAGE DE L'OXYGENE DANS LES METAUX ET LES OXYDES A L'AIDE DU MONOCHLORURE DE SOUFRE S_2Cl_2. III. DOSAGE DE L'OXYGENE DANS LES OXYDES DE CHROME, DE TITANE ET DE ZIRCONIUM ET DANS QUELQUES METAUX ET ALLIAGES. (Determination of Oxygen in Metals and Oxides Using Sulfur Monochloride S_2Cl_2. III. Determination of Oxygen in Oxides of Chromium, Titanium, and Zirconium and in Several Metal Alloys.) K. E. Kleiner and N. V. Obolonchik. Translated into French from Ukrain. Khim. Zhur., 25: 370-3(1959). 11p.

The S_2Cl_2 method for determining O_2 in metal oxides is extended to ZrO_2, TiO_2, and Cr_2O_3. The study includes the effects of temperature and prior bromidation. It was found that O_2 could be determined by this method in ZrO_2, TiO_2, Cr_2O_3, Cu, Cd, Ni, Cr, Ti, Zr, Ni–Mo, and W–Ni alloys. The method is based on treatment by S_2Cl_2 vapor at 600 to 900°C in a N_2 current. The equipment used is made of graphite, which does not react with S_2Cl_2. (T.R.H.)

10848 (CEA-tr-R-1062) DOSAGE DU STRONTIUM RADIOACTIF DANS LES EAUX DES BASSINS OUVERTS. (Determination of Radiostrontium in Water of Open Basins.) V. L. Zolotavin and L. K. Ponomareva. Translated into French from Radiokhimiya, 2: 104-6(1960). 8p.

A method for determining Sr^{89} and Sr^{90} in small amounts in water is offered. It is based on precipitation by sodium rhodizonate. The method takes 1.5 to 2 hr to run and has a maximum relative error of ±10%. Activities up to 5×10^{-11} c/l can be determined, that is, up to the lower permissible limit. The determination is not interfered with by Cs^{137}, Ru^{106}, Ce^{144}, and Zr^{95}. (T.R.H.)

10849 (DEG-Inf. Ser.-123) THE PHOTONEUTRONIC METHOD OF DETERMINATION OF THE CONCENTRATION OF DEUTERIUM IN NATURAL WATER. V. I. Baranov, V. K. Khristianov, and B. V. Karasev. Translated by E. Bevitt from Doklady Akad. Nauk S.S.S.R., 129: 1035-7 (1959). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 8461.

10850 (UCRL-Trans-621(L)) CONTINUOUS COULOMETRIC DETERMINATION OF OXYGEN IN A GAS. Isamu Sakamaki and Shinzo Yuki. Translated from Bunseki Kagaku, 7: 33-7(1958). 13p.

Continuous determination of oxygen (approximately 1 vol.%) in a gas was conducted by a coulometric method. A solution of purified chromium chloride was used for continuous gas absorption after electrolytic reduction with a mercury cathode. The Cr^{2+} concentration of the electrolyte increased or decreased with oxygen quantity. In order to provide that the concentration be constant, the Cr^{2+} was detected by a constant-current polarization method. Results of measurements indicated a good correspondence between the electrolytic current and the oxygen quantity. (auth)

10851 DETERMINATION OF THORIUM WITH HYPOPHOSPHORIC ACID IN THE PRESENCE OF PYROCATECHINE VIOLET "VPC." C. Dragulescu, T. Simonescu, and Doina Lazar-Jucu. Acad. rep. populare, Romine, Baza cercetări stiinţ. Timişoara, Studii cercetări ştiinţe chimice, 7: No. 1-2, 15-20(1960). (In Romanian).

A method is presented for the volumetric determination of thorium with hypophosphoric acid. The titration is in the presence of pyrocathechine violet. The method gives satisfactory results in the determination of concentrations from 1 to 28 mg in a volume of 100 cm^3. Under the same conditions thorium can be used to titrate hypophosphoric acid in the presence of the same indicator. Satisfactory results are obtained for microquantities (10 to 40 γ P_2O_6 in 1 cm^3). The method is unique by its simplicity, rapidity, and precision. (tr-auth)

10852 THE DETERMINATION OF AIRBORNE RADIOACTIVITY. L. R. Setter and G. I. Coats (U. S. Public Health Service, Cincinnati). Am. Ind. Hyg. Assoc. J., 22: 64-9(Feb. 1961).

Practical procedures for the gross differentiation and quantitative determination of natural and artificial airborne particulate radioactivities are presented. The proper choice of instruments and time of counting are necessary for the separate determinations. Details of methods are given with formulas for calculations. (auth)

10853 NULL-POINT POTENTIOMETRIC DETERMINATION OF FLUORIDE. T. A. O'Donnell and D. F. Stewart (Univ. of Melbourne). Anal. Chem., 33: 337-41(Mar. 1961).

A simple and accurate null-point potentiometric method was used to determine fluoride in various elutes and distillates. The procedure is based on the complexing of fluoride with cesium(IV) and the resultant decrease of the cerium(IV)-cerium(III) redox potential. Anions, chlorides, and nitrates do not interfere. (auth)

10854 POTENTIOMETRIC DETERMINATION OF CHLORINE BOUND TO BORON IN MIXTURES CONTAINING 2-CHLOROVINYL BORON CHLORIDES AND ETHYL BORON CHLORIDES. H. G. Nadeau, D. M. Oaks, and R. D. Buxton (Olin Mathieson Chemical Corp., New Haven). Anal. Chem., 33: 341-2(Mar. 1961).

A potentiometric method was devised for determining chlorine bound to boron in organoboron compounds. The hydrochloric acid formed through esterification of the chlorine bound to boron was titrated potentiometrically with standard silver nitrate. (auth)

10855 DETERMINATION OF THE STOICHIOMETRY OF URANIUM DIOXIDE BY CONTROLLED POTENTIAL COULOMETRY. R. W. Stromatt and R. E. Connally (General Electric Co., Richland, Wash.). Anal. Chem., 33: 345-6(Mar. 1961). (HW-SA-1931)

A controlled potential coulometric titration procedure was used to determine the oxygen to uranium ratio of uranium oxides. The sample was dissolved in hot phosphoric acid in the absence of oxygen, and uranium(VI) and total uranium are determined. The results of these titrations are equation factors in the calculation of the uranium-oxygen ratio. (auth)

10856 X-RAY SPECTROMETRIC DETERMINATION OF STRONTIUM IN HUMAN SERUM AND BONE. Samuel Natelson and Bertrum Sheid (Roosevelt Hospital, New York). Anal. Chem., 33: 396-401(Mar. 1961).

A convenient and accurate technique for the estimation of strontium with the x-ray spectrometer in human serum and bone is described. For bone a calcium–strontium ratio of 1204 and 1231 is found for rib and skull, respectively, in the human. For human serum a calcium–strontium ratio of 390 is obtained. Normal human serum contains 25.6 μg of strontium per 100 ml with a standard deviation of ±1.02

for six pools. Fifteen sera, both normal and abnormal, taken at random from the routine clinical laboratory, yielded values ranging from 16.4 to 31.0 μg per 100 ml. An instrument is described for evaporating a strontium solution onto filter paper to obtain a relatively uniform spot for analysis by x-ray spectrometry. (auth)

10857 SPECTROCHEMICAL DETERMINATION OF YTTRIUM IN BIOLOGICAL MATERIALS. Clarence L. Grant (Rutgers State Univ., New Brunswick, N. J.). Anal. Chem., 33: 401-4(Mar. 1961).

Ion exchange enrichment technique was combined with spectrochemical analysis to determine ytterium in bone ash and egg shells. The procedure offers extreme versatility in handling samples of different sizes and ytterium concentration. Elements of the rare-earth group may be determined by this procedure. (auth)

10858 SPECTROPHOTOMETRIC DETERMINATION OF TECHNETIUM WITH TOLUENE-3, 4-DITHIOL. Francis J. Miller and Paul F. Thomason (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 404-6(Mar. 1961).

Microgram quantities of technetium were determined by spectrophotometric procedure. Technetium was reacted with toluene-3,4-dithiol in acid medium and the complex extracted with carbon tetrachloride. The color intensity was measured at 450 mμ. Separation of technetium was required since many elements interfere. (auth)

10859 DETERMINATION OF DISSOLVED RADIUM. A. S. Goldin (Robert A. Taft Sanitary Engineering Center, Cincinnati). Anal. Chem., 33: 406-9(Mar. 1961).

A radiochemical procedure was developed to determine dissolved radium in public water supplies. Radium was coprecipitated with barium and lead sulfates using sulfuric acid. The carrier and radium were dissolved in nitric acid and reprecipitated with EDTA. The barium sulfate precipitate was washed and transferred to a planchet for counting. (auth)

10860 DETERMINATION OF TRITIUM IN WATER AND URINE. LIQUID SCINTILLATION COUNTING AND RATE-OF-DRIFT DETERMINATION. Frank E. Butler (E. I. du Pont de Nemours & Co., Inc., Aiken, S. C.). Anal. Chem., 33: 409-14(Mar. 1961).

Liquid scintillation counting and rate-of-drift determination were two techniques employed for the determination of H^3 in water and urine. The lower limit of detection for both procedures was about 0.005 μc per liter. The rate-of-drift technique was less expensive and analyzed 4 to 6 samples per day. (auth)

10861 APPLICATION OF PYROCATECHOL VIOLET AS A COLORIMETRIC REAGENT FOR TIN. W. J. Ross and J. C. White (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 421-4(Mar. 1961).

Pyrocatechol Violet was applied as a sensitive reagent for the colorimetric determination of tin. This reagent formed a red-colored complex with quadrivalent tin at pH 2.5. The molar absorptivity was 65,000 at its maximum absorbance of 555 mμ. Bivalent tin did not form a complex with Pyrocatechol Violet. Interference was produced by those metal ions that form colored species with the reagent in solution where the pH is less than 5; these include zirconium, titanium, bismuth, antimony, gallium, and molybdenum. (auth)

10862 EXTRACTION OF TIN WITH TRIS(2-ETHYLHEXYL)PHOSPHINE OXIDE AND ITS DETERMINATION IN NONAQUEOUS MEDIUM WITH PYROCATECHOL VIOLET. W. J. Ross and J. C. White (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 424-7(Mar. 1961).

A sensitive spectrophotometric method was used to determine tin in alloys. Tin was extracted from solution with a cyclohexane solution of tris(2-ethylhexyl)phosphine oxide and complexed with Pyrocatechol Violet. Maximum absorbance was measured at 575 mμ. Backwashing removed gallium, antimony, iron, and molybdenum. (auth)

10863 POLARIMETRIC DETERMINATION OF BORON. Donald D. DeFord, Arthur S. Blonder, and Robert S. Braman (Northwestern Univ., Evanston, Ill.). Anal. Chem., 33: 471-2(Mar. 1961).

A method is given for determining borate under conditions which prohibit the use of more conventional methods such as acid-base titrimetry. This method is based on the formation of a complex by borate ion with mannitol and the measurement of the optical polarization of the complex. Two versions of the method are outlined, one for determining total boron as boric acid or borate salts and the other for determining borate in borohydride salts. (D.L.C.)

10864 DETERMINATION OF CARBON, OXYGEN, AND SILICON IN SOLIDS BY ACTIVATION ANALYSIS WITH 15-MEV DEUTERONS. John W. Winchester and Michael L. Bottino (Massachusetts Inst. of Tech., Cambridge). Anal. Chem., 33: 472-3(Mar. 1961).

Determination of small amounts of carbon as low as a few tenths of 1% in pure SiO_2 can be carried out by activation with 15-Mev deuterons. Powdered samples contained in capsules and foils are bombarded by 15-Mev deuterons from a cyclotron; the deuteron energy is reduced to 0 to 8 Mev by absorption in capsules and foils. The C/O ratio is determined by analysis of a decay curve of the annihilation positron γ activity, while the Si/O ratio is determined by γ and β counting. (D.L.C.)

10865 A METHOD FOR DETERMINING BARIUM-140 AND LANTHANUM-140 IN A MIXTURE OF THE TWO RADIOISOTOPES. William B. Lane (Naval Radiological Defense Lab., San Francisco). Anal. Chem., 33: 478 (Mar. 1961).

A method is given for determining Ba^{140} and La^{140} in a mixture with a NaI crystal scintillation counter and a 4 π ionization chamber. (D.L.C.)

10866 ANALYTICAL CHEMISTRY OF BERYLLIUM. A REVIEW. L. E. Smythe and R. N. Whittem (Australian Atomic Energy Commission Research Establishment, Sydney). Analyst 86: 83-94(Feb. 1961).

A review is presented on current methods for beryllium determination. The methods range from gravimetric to radiochemical and spectrometric. Analysis of beryllium for impurities is treated. A bibliography of 159 references is included. (D.L.C.)

10867 RAPID DETERMINATION OF BERYLLIUM. A PAPER-CHROMATOGRAPHIC METHOD. D. Ader and A. Alon (Mining Industries Labs., Haifa, Israel). Analyst 86: 125-9(Feb. 1961).

A simple, rapid, and sensitive paper chromatographic method was developed for determining beryllium in beryllium-containing ores and allied materials. Eriochrome cyanine R is used as color-forming reagent, and interference is overcome by impregnating the paper with ethylenediaminetetraacetic acid. As little as 0.002 μg of beryllium can be detected. (auth)

10868 DETERMINATION OF SAMARIUM AND OTHER RARE EARTHS. L. R. Pittwell (Dominion Magnesium Ltd., Haley, Ont.). Analyst 86: 137-40(Feb. 1961).

Previous methods for determining samarium and the reasons for their failure are reviewed. Samarium lines in the region 2000 to 4350 A and several in the visible region

are evaluated for analytical use. A spectrographic method using lanthanum as internal standard was developed for determination of samarium and applied to mixtures of rare earths, thorium, zirconium, calcium, and magnesium with success (error ≤10%). A method was also developed for determination of rare earths, using aluminum as carrier and internal standard. (D.L.C.)

10869 USE OF (α,n) REACTIONS IN QUANTITATIVE ASSAYS OF DRESSING PRODUCTS FOR BERYLLIUM, BORON, AND FLUORINE. N. I. Plaksin, V. N. Smirnov, and L. P. Starchik. Atomnaya Energ. 9: 361-5(Nov. 1960). (In Russian)

Descriptions are given of the rapid method using (α,n) reactions for quantitative control of beryllium, boron, and fluorine content in dressing products. Po^{210} with an activity of 250 μc was used as α source. The number of neutrons knocked out by α particles from enriched products is recorded by neutron counters and the amount of beryllium, boron, and fluorine concentration in the product is determined. The method can be utilized for recording (with an accuracy of 1.5 to 2%) the enrichment products of beryllium, fluorine, and boron ores, and, also, rich ores containing fluorine and boron. The content of the element is determined with a constant amount of other admixtures with high (α,n) reaction yield. (tr-auth)

10870 POLAROGRAPHIC DETERMINATION OF THE COMPOSITION OF TETRAVALENT CERIUM PYROPHOSPHATE COMPLEX. V. M. Tarayan, L. A. Eliazyan, and G. A. Darbinyan (Inst. of Geology, Academy of Sciences, Armenian S.S.R.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Khim. Nauk, 12: 333–40(1959). (In Russian)

The feasibility of applying the Jander and Spandau formula for determining the molecular weight of pyrophosphate complexes of trivalent manganese and tetravalent cerium was verified by polarographic determination of Mn(III) and Ce(IV) coefficients of diffusion in pyrophosphate solutions. The formula for the trivalent manganese complex is $Mn(H_2P_2O_7)^{3-}$, where p = 3, which is in good agreement with published data. The cerium pyrophosphate complexes at pH = 4.25 and 7.50 are described by the formulas $[Ce(H_2P_2O_7)]^{2-}$ and $[Ce(HP_2O_7)]^{2-}$, respectively. Polarographic determination of tetravalent cerium in 0.4 pyrophosphate at +0.1 to 0.00 intensity (in relation to saturated calomel electrode) was achieved on the basis of proportionality between diffusion current magnitude and the tetravalent cerium pyrophosphate concentrations. (R.V.J.)

10871 DETERMINATION OF THE INDIVIDUAL RARE EARTH ELEMENTS IN THE RARE EARTH MINERALS BY NEUTRON ACTIVATION METHOD. DETERMINATION OF THE INDIVIDUAL RARE EARTH ELEMENTS IN MONAZITE AND ALLANITE. Isao Fujii (Tokyo Shibaura Elec. Co.). J. At. Energy Soc. Japan, 3: 9-18(1961). (In Japanese)

A method for the quantitative separation and determination of the individual rare-earth elements in the rare-earth minerals which utilizes ion-exchange chromatography (0.5M ammonium lactate in pH = 3.60, 4.60) and pile neutron (JRR-1, 10^{11} neutrons/cm^2/sec) activation is presented. After separation by the ion-exchange method using ammonium lactate at 87°C and destruction of the organic reagent, the rare earths were determined by the photometric method (Neothorin). Analyses of three monazites and an allanite were carried out with precision. (auth)

10872 A METHOD FOR ^{90}Sr DETERMINATION USING ^{85}Sr LABELLED CARRIER. J. Gilat (Israel Atomic Energy Commission Labs., Rehovoth). J. Inorg. & Nuclear Chem., 16: 147–8(Nov. 1960). (In English)

A method for the determination of Sr^{90} using Sr^{85}-labeled strontium-carrier solution was developed. The Sr^{85} γ activity enables a direct determination of the strontium-carrier recovery, thus obviating the need for chemical isolation of strontium. This activity does not interfere with the assay Sr^{90} which is carried out, as usual, by β counting of the separated Y^{90} fraction. The over-all standard deviation was 3 to 6%. The method was applied to the analysis of two local soils, and good results were obtained. (M.C.G.)

10873 THE DETERMINATION OF RADIUM AT LOW CONCENTRATION IN WATERS BY SCINTILLATION COUNTING OF ELECTRODEPOSITED DECAY PRODUCTS OF RADON. Josef Klumpar, Miroslava Majerová, and Pavel Jiroušek. Jaderná energie, 6: 404-8(1960). (In Czech)

A scintillation device was designed on the basis of electrodeposition of decay products of radon and calibrated for the measurement of low concentrations of radium in waters without preliminary chemical treatment. The sensitivity of the method at prescribed voluminal relations and the natural background corresponds to the content of 6.3×10^{-14} g radium in 1 liter of water after a 4-day accumulation. The relations for the efficiency and the target activity increase in time were derived. (auth)

10874 NEUTRON ACTIVATION ANALYSIS OF MINERALS AND ROCKS. Liboslav Šimon. Jaderna energie, 6: 409-14(1960). (In Czech)

The present classical methods of determining elementary constitution of minerals and rocks were replaced by a simple, quick, and sensitive neutron activation analysis. The bases of this new method and its application in laboratory and field are briefly described. (auth)

10875 DETERMINATION OF TRACE AMOUNTS OF MOLYBDENUM IN URANIUM BY THE COLOR DEVELOPMENT IN THE SOLVENT LAYER. Takayoshi Yoshimori (Gifu Univ., Japan) and Tsugio Takeuchi. Japan Analyst, 9: 689-92(Aug. 1960). (In Japanese)

A simplified procedure for the determination of molybdenum in metallic uranium and in uranium oxide was proposed. The sample was dissolved in hydrochloric acid and hydrogen peroxide. Molybdenum in the solution was extracted into butyl acetate and washed with dilute hydrochloric acid. The butyl acetate extract was shaken with the dilute hydrochloric acid solution containing ammonium thiocyanate, stannous chloride, and perchloric acid, and the color developed in the butyl acetate layer was measured at about 460 mμ. Satisfactory results were obtained over the range of 0 to 20 ppm of molybdenum. (auth)

10876 PHOTOMETRIC DETERMINATION OF TRACE OF IRON IN URANIUM METAL. Daido Ishii (Nagoya Univ., Japan). Japan Analyst, 9: 693-7(Aug. 1960). (In Japanese)

Determination of a trace of iron contained in uranium metal was made by the spectrophotometric method with 1,10-phenanthroline. In application of the method, influences of coexisting uranium are examined. In one procedure the sample is dissolved in hydrochloric acid and hydrogen peroxide. The solution is evaporated to dryness on the steam bath and dissolved in water. Hydroxylamine hydrochloric acid, acetic acid, ammonium acetate, and 1,10-phenanthroline solutions are then added. The red color of 1,10-phenanthroline ferrous complex is measured by the light transmittancy of the sample solution at 508 mμ. In this case 10 to 300 ppm of iron in uranium metal can be determined under the coexistence of uranium. In another procedure the sample is dissolved in hydrochloric acid and hydrogen peroxide. Ferric iron is reduced to ferrous by sodium thiosulfate. Uranium is separated by TBP–C_6H_6

extraction. Ferrous iron is oxidized again by adding hydrogen peroxide and bromine water and is extracted with TBP–C_6H_6. Iron is back-extracted with water from organic layer and then spectrophotometrically determined in the same way as in the first procedure. In this method 2 to 60 ppm of iron can be determined. This method of separation, examined by using Fe^{55+59} as a tracer, was found to be adequate for the purpose. (auth)

10877 PHOTOMETRIC DETERMINATION OF TRACE OF MANGANESE IN URANIUM METAL. Daido Ishii (Nagoya Univ., Japan). Japan Analyst, 9: 689-700(Aug. 1960). (In Japanese)

Determination of a trace of manganese contained in uranium metal has been made by the spectrophotometric method with permanganate. The sample is dissolved in hydrochloric acid and excess nitric acid. Hydrochloric acid is removed by evaporation. Uranium is separated from a nitric acid (4N to 6N) solution with TBP–CCl_4. Sulfuric acid is added, and the solution is heated to fume; water, silver nitrate, and ammonium persulfate solution are added and boiled. Manganese in the sample solution is oxidized to permanganate. The color of permanganate is measured by the light transmittancy at 525 mμ. When 2 g of the sample is taken and the volume of permanganate solution is made up to 10 ml, as low as 2 ppm manganese in uranium metal can be determined. (auth)

10878 SEPARATION OF RARE EARTH ELEMENTS IN IRON AND STEEL. Shiro Watanabe (Fuji Iron and Steel Co., Ltd. Kamaishi Iron Works, Japan). Japan Analyst, 9: 736-41(Sept. 1960). (In Japanese)

Rare-earth elements are often used for cast iron and steel, and it creates a need for the establishment of an adequate method of chemical analysis for total rare-earth elements or cerium in iron and steel. After some experiments using the radioactive Ce^{144} as a tracer, a procedure for the determination with fluoride separation of total rare-earth elements in iron and steel was developed. A 2-g sample is dissolved in 6N sulfuric acid, filtered into a polyethylene beaker (300-ml), and diluted to 100 ml; hydrofluoric acid (46%) and a small amount of filter paper are added. The solution is then heated for 10 to 20 minutes, and the fluoride precipitate is filtered and washed thoroughly with a 0.5% sulfuric acid solution containing 5% hydrofluoric acid. The resultant total rare-earth fluoride is ignited in a platinum crucible and weighed as an oxide. (auth)

10879 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM WITH POTASSIUM SALT OF p-CARBOXYDIBENZOYLMETHANE. Yasuhiro Yamane and Tomoko Yoshida (Univ. of Chiba, Japan). Japan Analyst, 9: 763-9(Sept. 1960). (In Japanese)

The potassium salt of p-carboxydibenzoylmethane is soluble in water and forms a yellow colored water-soluble chelate compound with uranyl ion. Moreover, the reaction is very sensitive. Therefore the fundamental conditions for the determination of uranium by this new reagent have been investigated. The yellow chelate compound is stable and has a maximum absorbance at 398 to 402 mμ. The optimum pH is 7.3 to 7.8, and a mole ratio of the reagent to UO_2^{2+} is 2 to 1. The color reaction conforms to Beer's law up to 11γ per ml of uranium, and the molecular extinction coefficient is about 23,000 at 400 mμ. Although many elements interfere, the interferences are eliminated in the presence of masking agents such as EDTA and KCN. Therefore trace amounts of uranium may be determined in the presence of diverse metals of 5γ or 1γ per ml without prior separation. The recommended procedure is to pipet 10 ml of a neutralized solution containing 1 to 11γ per ml of uranium into a 25-ml volumetric flask, add 1 ml of 0.1% KCN, 1 ml of M/100 EDTA, and 10 ml of 0.05% reagent solution prepared by dissolving the reagent in borax–boric acid buffer solution (pH = 7.5), dilute to the mark with distilled water, mix well, and then heat in a water bath at 50°C for 10 min. Measure the absorbance at 400 or 410 mμ using the reagent blank. Find concentration of uranium by means of a calibration curve prepared by using known amounts of uranium. (auth)

10880 COULOMETRIC DETERMINATION OF MICROAMOUNT OF BORON BY THE PHOTOMETRIC END POINT DETECTION. Hiroshi Iinuma and Takayoshi Yoshimori (Gifu Univ., Japan). Japan Analyst, 9: 826-9(Oct. 1960). (In Japanese)

The coulometric titration method for the determination of microamounts of boron by using mannitol was investigated by means of photometric end-point detection. As an indicator, methyl red was the most satisfactory, and 1 to 50γ of boron were determined accurately by the proposed method. The method was applied for the determination of boron in steel. The separation of boron from a large amount of iron was effected by the methyl borate distillation method, and boron in steel could be determined with satisfactory results. (auth)

10881 THE QUANTITATIVE SPECTROGRAPHIC DETERMINATION OF TRACE ELEMENTS IN THORIUM OXIDE. Tokunosuke Nakazima and Hiroyuki Fukushima (Atomic Energy Research Inst., Tokyo). Japan Analyst, 9: 830-6(Oct. 1960). (In Japanese)

A spectrochemical method is presented for the quantitative analysis of thorium for 17 trace-impurity elements (Al, B, Be, Bi, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, P, Pb, Si, and V). Since thorium oxide is a highly refractory material, the carrier-distillation methods are successfully applied. A mixture of 96 parts of ThO_2 and 4 parts of AgCl is arced in a deep-cratered Scribner's pedestal type electrode at 12A. As little as 0.1 ppm of cadmium and 0.05 ppm of boron can be determined. Data are also given on the sensitivity and precision for the other elements. (auth)

10882 RAPID ABSORPTIOMETRIC DETERMINATION OF BERYLLIUM WITH ALUMINON. Yōhē Tsuchiya (Nagoya Municipal Industrial Research Inst., Japan). Japan Analyst, 9: 934-9(Nov. 1960). (In Japanese)

Beryllium forms a red complex with aluminon in a faintly acidic solution, the absorption maximum of the complex lying at near 540 mμ. It is found that the reaction itself and also the masking of intefering ions with EDTA had better be accelerated by heating of the solution and that the sensitivity becomes greater in sodium acetate buffer than in ammonium acetate buffer, the optimum pH for the reaction being dependent on concentration of aluminon or on presence of gelatin. Absorbancy increases with increasing concentration of aluminon and in presence of gelatin but decreases with increasing concentrations of EDTA and ammonium or alkali-metal ions. The effect of alkali-metal ions on the absorbancy decreases with increasing concentration of aluminon, although the effect of pH becomes greater. To a solution containing 4 to 32γ of beryllium are added 1 ml (or 5 ml) of 2.5% EDTA, 10 ml of reagent solution (0.500 g of aluminon, 272 g of sodium acetate trihydrate, and 27 ml of acetic acid in 1 liter, pH 5.3 ± 0.05), and 5 ml of 0.5% gelatin. The solution is gently boiled for 5 min, cooled, and diluted to 50 ml with water, the optimum pH in this case being 5.1 to 5.5. Absorbancy is measured with Hitachi No. 53 filter (530 mμ). The determination is carried out with an error of less than 2%, and the time re-

quired for an analysis is about 20 min. Aluminum less than 250-fold of beryllium and copper, iron, lead, zinc, calcium, or magnesium less than 2000-fold do not interfere. The method is easily applicable to various kinds of samples, i.e., beryllium ores, intermediates, or products from beryllium–copper industries. (auth)

10883 COLORIMETRIC DETERMINATION OF Be IN Be-Cu AND Be-Al ALLOYS. Katsuzo Kida, Mitsunobu Abe, Susumu Nishigaki, and Kazuo Kobayashi (Nippon Gaishi Kaisha, Ltd., Japan). Japan Analyst, 9: 1031-5(Dec. 1960). (In Japanese)

A rapid method for the colorimetric determination of beryllium with 8-hydroxyquinaldine in beryllium–copper and beryllium–aluminum alloys was studied and found to be effective for the estimation of beryllium in alloys (1 to 5% beryllium) within an error of 0.02%. Copper and aluminum were masked by KCN and EDTA, respectively. KCN did not affect the absorbancy of the beryllium complex, but EDTA lowered it to a definite extent. (auth)

10884 VOLUMETRIC DETERMINATION OF ZINC BY THE USE OF URANYL ACETATE, URANYL NITRATE OR AMMONIUM MOLYBDATE TEST PAPER AS AN EXTERNAL INDICATOR. Tomoyuki Mukoyama and Norio Ichinose (Yamanashi Univ., Japan). Japan Analyst, 9: 1041-4(Dec. 1960). (In Japanese)

The application of test paper as an external indicator has been studied in zinc titration with potassium ferrocyanide solution. The test papers are prepared by dipping the strips of filter paper in 5% uranyl acetate, 10% uranyl nitrate, or 10% ammonium molybdate and drying it in an electric oven at about 130°C for 5 min. These papers can be preserved in a desiccator for a long time without any degree of sensibility change. Among the papers with the same kind of salts, the paper with the compound of lower solubility is more sensitive. The spot test on the test paper for ferrocyanide is sensitively done by placing a very small quantity of the sample solution 2 or 3 times on the same spot, using a glass rod with a fine tip (diameters 1 mm). The test-paper method for detecting the end point is superior to the ordinary spot-plate method, in sensibility, simplicity, and rapidity. The ammonium molybdate test paper is most sensitively used to the zinc titration unless the solution contains hydrogen sulfide. The uranyl acetate paper has an advantage of application for the zinc solution containing hydrogen sulfide without sensibility lowering. (auth)

10885 REDUCTION OF EUROPIUM AND TERBIUM AT DROPPING MERCURY ELECTRODE. Akio Iwase (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 81: 739-44(May 1960). (In Japanese)

The influences of pH upon the current-voltage curves and on the number of reducing electrons were studied for each ion(III) of europium and terbium. The polarogram was recorded under the following conditions: supporting electrolyte, 0.1M LiCl; maximum suppresser, 0.01% gelatin; concentration range of depolarizer, 10^{-3} to 10^{-4} mole/l; pH, 2 to 5; temperature, 25°C. In the case of europium a two-step wave due to the reduction of $Eu^{3+} \rightarrow Eu^{2+}$ and $Eu^{2+} \rightarrow Eu^{0}$, was observed. In the case of terbium, waves apart from the hydrogen waves were observed but the two-step wave ($Tb^{3+} \rightarrow Tb^{2+}$ and $Tb^{2+} \rightarrow Tb^{0}$) was not observed. These values of half-wave potential were −0.670 v (the first wave of europium, at pH 4.0), −1.945 v (the second wave of europium), and −1.818 v vs. S.C.E. (terbium, at pH 3.0), respectively. When pH of the solution was changed from 4.5 to 2.4, the halfwave potentials of europium (the first wave) and terbium shifted to the more negative side, and the first wave of europium changed from reversible to irreversible nature and the wave of terbium changed from irreversible to reversible nature (the plot of log $i/(i_d - i)$ against $E_{d\text{-}e}$ of the wave of terbium is a straight line with a slope of 0.02 v, which coincides well with the theoretical value 0.02 v, in the case of three-electron reduction at lower pH range than 3). In the case of the second wave of europium, the plot of its log $i/i_d - i)$ against $E_{d\text{-}e}$ gives a straight line with a slope of 0.03 v. In both cases of europium and that of terbium, the limiting currents were diffusion-controlled. The values of diffusion current constants obtained were 1.50 ± 0.01 (the first wave of europium), 3.02 ± 0.03 (the second wave of europium) and 4.50 ± 0.05 (terbium), respectively. The constant of diffusion current coincides with the theoretical value calculated approximately from the Ilkovič equation, using the diffusion coefficient of dysprosium ion (III), on the assumption that the reduction proceeds as $Eu^{3+} \rightarrow Eu^{2+}$, $Eu^{2+} \rightarrow Eu^{0}$, and $Tb^{3+} \rightarrow Tb^{0}$. Accordingly, the number of reducing electrons of terbium must be three. (auth)

10886 RAPID ANALYSIS OF ALKALINE EARTHS. I. A NEW SEPARATION METHOD OF STRONTIUM FROM CALCIUM BY USE OF DIHYDROXYETHYLGLYCINE AS A MASKING REAGENT. Susumu Takamoto (Gakushuin Univ., Tokyo). Nippon Kagaku Zasshi, 81: 915-18(June 1960).

Dihydroxyethylglycine forms weak complexes with alkaline earths in alkaline medium. Its strontium complex has lower stability than calcium complex, hence if ammonium sulfate is added to an ammoniacal solution containing strontium and calcium complexes, only strontium sulfate precipitates by heating. Alcohol is also added for completion of the precipitation. The solution is ice-cooled for 1 hr, then centrifuged. Washed precipitate is dissolved with excess of disodium ethylenediaminetetraacetic solution, and the strontium can be determined by back-titration with magnesium solution at pH 10 by the usual way. By the method, many samples containing less than 0.2 m mole of strontium and calcium in 2 ml can be analyzed much more rapidly than by ordinary extraction method. Less than 0.2 m mole of magnesium and potassium, 1 m mole of sodium, 3 m mole of ammonium, and 1 m mole of anions such as nitrate, perchlorate, chloride, bromide, iodide, thiocyanate, and acetate do not interfere; most of the anions which precipitate with calcium interfere. (auth)

10887 DETERMINATION OF METALLIC IONS BY MEANS OF THEIR OXALATES. XI. ON THE DETERMINATION OF THORIUM IN THE PRESENCE OF ZIRCONIUM. Kyozo Kawagaki (Niigata Univ., Japan). Nippon Kagaku Zasshi, 81: 918-20(June 1960). (In Japanese)

The oxalate method for the determination of thorium in the presence of zirconium was studied. The reaction between zirconium salts and oxalic acid is so complicated that it has not yet been studied from the point of analytical chemistry. The object of this investigation is first to find the conditions under which zirconium is to be precipitated as oxalate and to establish a method for determination of thorium by using oxalic acid alone in the presence of zirconium. The results showed that thorium can be determined quantitatively in the presence of zirconium when the following conditions are satisfied: (1) The molar ratio of zirconium to thorium is 0.9 or less; (2) the amount of oxalic acid is 20 cc when 0.5N solution is used; (3) the total volume of the solution is 100 to 200 cc; and (4) the time of heating on a water bath is 30 min and that of standing is 1 hr. (auth)

10888 RADIOACTIVATION ANALYSIS OF INDIUM USING RADIUM + BERYLLIUM NEUTRON SOURCE. II. STUDIES ON NEUTRON IRRADIATION METHOD FOR SAMPLE OF AQUEOUS SOLUTION. Yuzuru Kusaka and Haruo

Tsuji (Konan Univ., Kobe, Japan). Nippon Kagaku Zasshi, 81: 1087-9(July 1960). (In Japanese)

The radioactivation analysis of indium, in which the sample solution itself is irradiated by neutrons from the radium + beryllium neutron source, was studied. From the experiments, the facts described below were elucidated. As to the thermal neutron flux in the neutron moderator, that is, in paraffin or in water, a maximum point is found at the distance of 0.5 cm from the source in paraffin and at 1 cm in water. Within about 5 cm from the source, the thermal neutron flux in paraffin is about 20% greater than in water. In the method in which the sample to be irradiated is the aqueous solution in the spherical flask of soft glass surrounded by paraffin or water used as the neutron reflector and the neutron source is placed on its center, the radioactivity induced in the definite quantity of indium becomes a maximum strength at about 100 cc of the sample volume and in general the radioactivity obtained by paraffin reflector is about 8% greater than obtained by water. In the case of 115 cc of the sample volume, the induced radioactivity is proportionally increased with the indium content up to about 600 mg, and in the case of 5 cc, on the other hand, the self-absorption effect of the sample for neutrons is appreciably greater than in the 115 cc. The interfering degree of the other elements in the analysis, which is based upon the self-absorption effect for neutrons can be inferred from the values of the neutron absorption cross section. Some analytical techniques applicable for the various samples were introduced. (auth)

10889 POLAROGRAPHIC ANALYSIS OF URANIUM. II. STUDIES ON THE CATALYTIC NITRATE WAVE AND ITS APPLICATION FOR ANALYSIS OF TRACE AMOUNT OF URANIUM. Toshifumi Murata (Hitachi Research Lab., Hitachi Co. Ltd., Ibaragi, Japan). Nippon Kagaku Zasshi, 81: 1240-4(Aug. 1960). (In Japanese)

A polarographic method for the determination of micro quantities of uranium was developed. The method is based on the catalytic wave of uranyl ions which appear in the presence of nitrate ions. Several factors which affect the height and the potential of the wave were investigated. A supporting electrolyte which consists of 0.015M nitric acid, 0.015M potassium nitrate, 0.005M potassium chloride, and 0.0002% Methyl Red is most suitable for the determination of a trace amount of uranyl ion in the absence of other ions. In this solution, the catalytic wave is proportional to the concentration of uranyl ion in the range of 10^{-6} to 10^{-6}M and is much larger than that in the solution proposed by Kolthoff. The reaction mechanism of the catalytic wave is also discussed. (auth)

10890 POLAROGRAPHIC ANALYSIS OF URANIUM. III. DETERMINATION OF URANIUM IN NUCLEAR FUEL REPROCESSING. Toshifumi Murata (Hitachi Research Lab., Hitachi Co. Ltd., Ibaragi, Japan). Nippon Kagaku Zasshi, 81: 1244-8(Aug. 1960). (In Japanese)

The determination of uranium content in fuel reprocessing stream solutions is interfered with by the presence of various substances such as TBP, Fe^{3+}, Al^{2+}, and NO_2^-. Polarographic methods were developed for the rapid analysis of uranium in reprocessing aqueous solution. TBP and NO_2^- did not significantly interfere in alcoholic nitric acid solution. The practical analysis of the synthesized reprocessing sample solutions was satisfactory when 50% C_2H_5OH–0.5M HNO_3 mixture was used as a supporting electrolyte solution. (auth)

10891 CHEMICAL STUDIES ON RADIOACTIVE INDICATORS (XXI) CARRIER-FREE SEPARATION OF TECHNETIUM. Masayoshi Ishibashi, Taitiro Fujinaga, and Mutsuo Koyama (Kyoto Univ.). Nippon Kagaku Zasshi, 81: 1260-3(Aug. 1960). (In Japanese)

Technetium produced by proton bombardment in molybdenum targets was isolated and purified chemically in order to prepare a micro source for a measurement of nuclear characteristics and also to study chemical characteristics of the element. The separation method by distillation was mainly examined and it was found that the distillation efficiency of technetium from H_2SO_4 solution was greatly improved by the addition of oxidizing agents, i.e., HNO_3 or $HClO_4$. In the distillation, technetium can be separated from such nuclides as Sr^{90}–Y^{90}, Cs^{137}–Ba^{137}, Ce^{144}–Pr^{144}, and Mo. Pyridine extraction applied prior to the distillation was also found to be very effective as the preliminary separation of technetium from molybdenum and/or the fission products. Anions such as NO_3^-, SO_4^{2-}, and Cl^- can be removed in the course of the extraction. (auth)

10892 REDUCTION OF GADOLINIUM, DYSPROSIUM, HOLMIUM AND ERBIUM AT DROPPING MERCURY ELECTRODE. Akio Iwase (Yamagata Univ., Japan). Nippon Kagaku Zasshi, 81: 1266-71(Aug. 1960). (In Japanese)

The influences of pH upon the current-potential curves and on the number of reducing electrons were studied for each ion(III) of gadolinium, dysprosium, holmium, and erbium. The waves apart from the hydrogen waves were observed in all cases of gadolinium, dysprosium, holmium, and erbium. The two-step waves ($R^{3+} \rightarrow R^{2+}$ and $R^{2+} \rightarrow R^0$) were not observed in the solution of 0.1M LiCl with 0.01% gelatin. The half-wave potential of each ion under these conditions was −1.80 v vs. S. C. E. at pH 3.0, independent of the concentration of depolarizer, and shifted to more negative potential with decrease of pH (between ~2.3 to 5.0). The plot of log $i/(i_d - i)$ against E_{dc} gave a straight line with a slope of 0.02 v which coincides well with the theoretical value of 0.02 v, in the case of three electron-reduction at lower pH range than ~3.2, but the process of electrode reaction changed from reversible to irreversible nature at a higher pH range than 3.2. The limiting current was diffusion controlled for each ion. The diffusion current constant agreed well with the theoretical diffusion current constant (the reduction of $Gd^{3+} \rightarrow Gd^0$, $Dy^{3+} \rightarrow Dy^0$, $Ho^{3+} \rightarrow Ho^0$, and $Er^{3+} \rightarrow Er^0$ is assumed) calculated from the Kikovič equation, using the diffusion coefficient of each ion. The order of decreasing amounts of the differences between the standard potentials and half-wave potentials is parallel with radius of ions and with the decreasing amounts of basicity. (auth)

10893 STUDIES OF SEPARATION OF ZIRCONIUM AND HAFNIUM AND THEIR MICRODETERMINATION. III. SPECTROPHOTOMETRIC DETERMINATION OF TRACE OF ZIRCONIUM OR HAFNIUM WITH QUERCETIN SULFONATE. Yoshio Hoshino (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 1273-7(Aug. 1960). (In Japanese)

Quercetin sulfonate, which is easily soluble in water, was used as a sensitive reagent for the determination of zirconium or hafnium. The aqueous solution of quercetin sulfonate forms a yellow complex with zirconium or hafnium which has an absorption band with a maximum lying at around 420 mμ wavelength. The favorable conditions for the determination are: the concentration of HCl and quercetin sulfonate is 0.2 to 0.5N and 2 to 3×10^{-4} mole/l, respectively. The working curves were prepared using the solution of 1 to 30 γ/50 ml of zirconium or hafnium at 420 to 440 mμ. They follow the Beer's law well. The molar absorbancy index of the zirconium complex is 3.67×10^4 in case the concentration of HCl and quercetin sulfonate is 0.2N and 2.23×10^{-4} mole/l, respectively, at 420 mμ; that

of the hafnium complex is almost the same value under the same conditions. The ratio of quercetin sulfonate to zirconium or hafnium in its complex is 1:1 under the condition. The interference of Fe^{3+} is removed by the addition of thioglycolic acid solution. (auth)

10894 STUDIES ON SEPARATION OF ZIRCONIUM AND HAFNIUM AND THEIR MICRODETERMINATION. IV. SPECTROPHOTOMETRIC DETERMINATION OF TRACE OF ZIRCONIUM OR HAFNIUM WITH MORIN. Yoshio Hoshino (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 1278-83(Aug. 1960). (In Japanese)

It was found that morin(5,7,2',4'-tetrahydroxyflavanol) has higher sensitivity than quercetin as a reagent for spectrophotometric determination of zirconium or hafnium. Ethanolic solution of morin has an absorption band with a maximum lying at around 360 mμ, and the complex with zirconium or hafnium has its maximum at around 420 mμ. Optimum conditions for determination are as follows: the concentration of HCl, morin, and ethanol is 0.5N, 3×10^{-4} mole/l and 30 to 50%, respectively. Working curves follow Beer's law in range of the concentration of 1 to 40 γ/50 ml of zirconium or hafnium at 410 to 430 mμ. It was revealed that the ratio of morin to zirconium or hafnium in the complex is 2:1 by Job's continuous variation method. Use of acetone as the solvent increases the sensitivity of determination. The molar absorbancy index of the zirconium and hafnium complex was found to be 7.30×10^4 and 7.22×10^4, respectively, under the condition of 30% acetone, 4% ethanol, 0.1N HCl, and 2.64×10^{-4} mole/l morin at 420 mμ. (auth)

10895 RAPID ANALYSIS OF ALKALINE EARTHS. II. SEPARATION OF BARIUM FROM STRONTIUM. Susumu Takamoto (Gakushuin Univ., Tokyo). Nippon Kagaku Zasshi, 81: 1539-42(Oct. 1960). (In Japanese)

A commonly used method for the separation of barium from strontium is that of the precipitation of barium as chromate under careful control of pH, but it is difficult to apply when a large amount of strontium is present. A modification of this procedure by the use of hydroxyethyliminodiacetic acid or nitrilotriacetic acid as a masking reagent is offered. When potassium chromate is added to an ammoniacal solution containing barium, strontium, and a large excess of the masking reagent, only barium chromate is precipitated. The solution is heated for 10 min on a boiling-water bath, and then ice-cooled for 1 hr. After centrifuging, the washed precipitate is dissolved with phosphoric acid and the chromate is titrated with ferrous solution, using sodium diphenylaminesulfonate as an indicator. By this method, less than 0.1 m mole of barium can easily be separated frdm less than 0.8 m mole of strontium with little coprecipitation. Nitrilotriacetic acid has stronger masking power than hydroxyethyliminodiacetic acid but it suffers from slight pH effect. Alkaline metal ions and common anions do not interfere but most of the anions which precipitate strontium, such as fluoride, nitrite, carbonate, oxalate, phosphate, etc., interfere. (auth)

10896 STUDIES ON SEPARATION OF ZIRCONIUM AND HAFNIUM AND THEIR MICRODETERMINATION. VI. MUTUAL SEPARATION OF ZIRCONIUM AND HAFNIUM BY SOLVENT EXTRACTION WITH CYCLOHEXANONE. Yoshio Hoshino (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 1574-8(Oct. 1960). (In Japanese)

Cyclohexanone was found to be a very excellent extraction solvent for the mutual separation of zirconium and hafnium. The distribution ratio (D: the ratio of the concentration of zirconium or hafnium in organic phase to that in aqueous phase) and the separation factor (the ratio of D_{Hf}/D_{Zr}) in this extraction were measured chiefly at 30°C. Results: Cyclohexanone as an extraction solvent is superior to methyl isobutyl ketone or diethyl ether in the following points: (1) It has high values of separation factor (maximum, about 120) and high distribution ratio (approximately 10 times the value of methyl isobutyl ketone); (2) the influence of ammonium sulfate concentration in aqueous phase on the separation factor is comparatively small; (3) the separation factor increases at lower temperatures; and (4) thiocyanic acid dissolved in cyclohexanone is relatively stable. (auth)

10897 NONDESTRUCTIVE DETERMINATION OF TRACE AMOUNT OF MANGANESE IN STEEL BY NEUTRON ACTIVATION. Hisashi Mori and Hirokazu Umezawa. Nippon Kinzoku Gakkai, 24: 641-5(1960). (In Japanese)

Trace amounts of manganese in steel was determined nondestructively by neutron activation analysis using the JRR-1 reactor (neutron flux: 10^{11}n/cm^2·sec). The induced radioactivity of Mn^{56} was measured with a well type scintillation counter and a γ spectrometer. The agreement between neutron activation analysis and chemical analysis was within ±10%. The relative error due to counting fluctuation was 2% for 0.01 r of manganese (2 hr irradiation). In order to eliminate the influence due to the activity of Cu^{64}, manganese activity was counted from 1 to 5 hr after the irradiation. (auth)

10898 MINOR-CONSTITUENT ANALYSIS WITH NEUTRON ACTIVATION. J. Hoste, F. Bouten, and F. Adams (Ghent Univ.). Nucleonics 19: No. 3, 118; 120-3(Mar. 1961).

Neutron activation can be used with an internal standard to determine minor constituents of concentration 0.001 to 1%. The basis of such an analytical method is presented. Using this method, manganese was determined in NBS steel No. 101d and a number of other steel standards. A table of steel constituents activated by thermal neutrons is given. Antimony can be determined in Pb–Sb alloys by using gold as an internal standard. (D.L.C.)

10899 EXTRACTION–PHOTOMETRIC METHOD OF DETERMINATION OF URANIUM WITH ARSENAZO III. V. I. Kuznetsov and S. B. Savvin. Radiokhimiya, 2: 682-6 (1960). (In Russian)

An extraction-photometric method is suggested for determining uranium with Arsenazo III. The method consists of butyl alcohol extraction from a saturated solution of Complexon III intensely colored by the UO_2^{2+}-diphenyl guanidine-Arsenazo III complex. The extract is analyzed photometrically at λ = 660 mμ. The determination of 1 to 50 μg of uranium is combined with simultaneous separation from other elements. Phosphates, fluorides, sulfates Fe, Al, and other elements do not interfere. (R.V.J.)

10900 DETERMINATION OF THORIUM BY FLUORESCENT X-RAY SPECTROGRAPHY. Maria Lucco Borlera (Politecnico, Turin). Ricerca sci., 30: 1723-5(Nov. 1960). (In Italian)

A fluorescent x-ray spectrographic method for the determination of thorium is described. Measurements were made by using uranium or mercury as internal standards and lithium fluoride as the analyzing crystal. (auth)

10901 ANALYSIS OF PURE METALS. DETERMINATION OF VANADIUM IMPURITIES IN TITANIUM. M. B. Shustova and V. A. Nazarenko (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zavodskaya Lab., 26: 1339-41(1960). (In Russian)

A method based on the catalytic acceleration by vanadium of the oxidation of aniline by $KClO_3$ was adapted for the determination of microquantities of this metal in titanium. A strong yellow-brown coloration was formed if the reaction

was catalyzed by vanadium; in the absence of this metal only a weak coloration was obtained. By extracting the reaction product with ethyl or amyl acetate, the presence of only 0.01 γ vanadium in 100 ml of sample may be determined, corresponding to a dilution factor of $1:10^{10}$. A wavelength of 390 mμ was used for quantitative measurements. Amounts of 5×10^{-5}% vanadium in titanium metal or in TiO_2 were determined with ease. If the sample contained too much molybdenum, as is the case of material prepared by the hot-wire method of decomposition of the iodide, the above method could not be used because the molybdenum would be extracted together with the vanadium. (TTT)

10902 POTENTIOMETRIC DETERMINATION OF BORON IN STEELS AND ALLOYS. P. Ya. Yakovlev and G. V. Kozina (Bardin Central Scientific Research Inst. of Ferrous Metallurgy, [USSR]). Zavodskaya Lab., 26: 1342-3(1960). (In Russian)

A potentiometric method based on the usual titration of boric acid by means of invert sugar and NaOH, using a glass electrode and a saturated calomel reference electrode in an open container, was developed. Prior to the analysis, Fe, Ni, Cu, Cr, Mn, and other cations were separated by precipitation. Although the solution was brought to boiling for 5 min, no losses due to volatility were observed. In order to eliminate the aluminum that interferes with the determination, the solution was treated with citric acid. The presence of vanadium and molybdenum did not influence the results. The whole analysis could be completed within 1.5 hr. (TTT)

10903 PHOTOMETRIC DETERMINATION OF URANIUM BY MEANS OF THE REAGENT ARSENAZO. V. I. Kuznetsov and T. N. Kukisheva. Zavodskaya Lab., 26: 1344-5(1960). (In Russian)

The reagent arsenazo, which forms a vivid blue-colored complex with hexavalent uranium, appears to be the most satisfactory for the photometric determination of uranium. A rapid method was developed avoiding the previously needed repeated extraction; it was found that by extracting the complex with methyl ethyl ketone, an enrichment factor of about 23,000 could be obtained. Addition of the compound complexon (III) further improved this situation. While the effect of Cu, Al, V, Ti, Fe, and Bi on the outcome of the analysis is rather minor, large amounts of zirconium must be removed from the sample prior to the determination by precipitation with orthophosphoric acid. Relatively large excesses of thorium may be tolerated by suitable changes in the operating procedure. (TTT)

10904 MASKING OF ZINC, CADMIUM, MERCURY, LEAD, AND TIN BY UNITHIOL DURING THE COMPLEXOMETRIC DETERMINATION OF STRONTIUM AND BARIUM. L. A. Vol'f (Kirov Textile Inst., Leningrad). Zavodskaya Lab., 26: 1353-4(1960). (In Russian)

Although used for calcium and magnesium, Trylon B and Eriochrome black cannot be used for the direct titration of strontium and barium in view of the lack of stability of the complexes formed. The need arose to develop a substitution reaction and suitable indicators for performing the titration. The complex developed by G. Anderegg et al. (Helvetica Chemica Acta, 37: 113-20(1954)), designated as cresolphthalexon (complexone (I)) in the form of its sodium salt, was found useful for this purpose. Various organic dyes were added to the solution to compensate for the coloration. As solutions of the indicator were rather unstable, the solid material mixed with NaCl was used. The titration was best carried out in a medium containing ammonia buffer at pH = 11. The presence of heavy metal ions interfered with the determination as they formed more stable complexes than strontium and barium. Use of cyanides was found to be undesirable in view of the toxicity of the material and its tendency to precipitate certain ions, but unithiol (sodium dimercaptopropanesulfonate) yielded good results. (TTT)

10905 FLAME-PHOTOMETRIC DETERMINATION OF CLARKE AMOUNTS OF CESIUM IN NATURAL MATERIALS ENRICHED IN POTASSIUM. E. A. Fabrikova (Inst. of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements, Academy of Sciences, Moscow). Zhur. Anal. Khim., 16: 22-4(Jan.-Feb. 1961). (In Russian)

It was found that cesium can be precipitated from sulfuric acid solutions together with ammonium silicomolybdate. A method was developed for the flame-photometric determination of small concentrations of cesium in natural materials with a high content of potassium. (auth)

10906 DETERMINATION OF COPPER AND MANGANESE CONTENT IN ORES BY NEUTRON RADIOACTIVATION ANALYSIS. E. M. Lobanov, O. M. Romanov, M. M. Romanov, and A. A. Khaidarov (Inst. of Nuclear Physics, Academy of Sciences, Tashkent, Uzbek S.S.R.). Zhur. Anal. Khim., 16: 25-8(Jan.-Feb. 1961). (In Russian)

The direct determination of 0.03 to 0.9% copper and 0.028 to 0.3% manganese is possible with the use of a γ scintillation spectrometer for recording the γ radiation of activated rock samples at the neutron flux about 10^7 neutron/cm^{-2}/sec^{-1}. The possible experimental error is ±5 to 8%. (auth)

10907 PHOTOMETRIC DETERMINATION OF RARE EARTHS WITH SALICYLFLUORONE. F. V. Zaikovskiĭ and G. F. Sadova (All-Union Inst. of Mineral Raw Materials, Moscow). Zhur. Anal. Khim., 16: 29-31(Jan.-Feb. 1961). (In Russian)

Salicylfluorone forms colored compounds with rare earths in a nearly neutral medium. The solutions follow Beer's law. Salicylfluorone is a more selective reagent as compared with arsenazo-1. The photometric determination of certain rare earths and their total with salcylfluorone is possible in the presence of sulfosalicylic acid to mask calcium and magnesium. (auth)

10908 ON COMPOUNDS OF MOLYBDENUM WITH THIOGLYCOLIC ACID AND ON A NEW PHOTOMETRIC METHOD FOR THE DETERMINATION OF MOLYBDENUM. A. I. Busev and Fan Chang (Moscow State Univ.). Zhur. Anal. Khim., 16: 39-50(Jan.-Feb. 1961). (In Russian)

Under certain conditions molybdenum forms with $HSCH_2COOH$ yellow compounds in pentavalent and sexavalent state in the molar ratio of 1:2. The maximum absorbances are correspondingly at 352.5 and 365 mμ, and molar extinction coefficients are 2400 and 4400. Molybdenum(III) does not form such a compound. The stability of molybdenum(V) and molybdenum(VI) compounds with $HSCH_2COOH$ depends on the acidity of the solution. In a moderately acid medium (pH 2.5) the molybdenum(VI) compound is unstable due to the reduction of molybdenum(VI) to molybdenum(V) with the reagent and formation of a molybdenum(V) compound with the excess $HSCH_2COOH$. The molybdenum(V) compound obtained is stable in acid solutions (pH 0.7 to 6). In acid solutions molybdenum(VI) reduces to molybdenum(V) quantitatively. In a weak acid medium (pH 2.5 to 6), molybdenum(VI) is slowly reduced with the reagent to molybdenum(V) only in the presence of a large excess of the reagent. When there is no large excess of the reagent, molybdenum(VI) compound is rather stable at a pH of 2.5 to 6. At higher pH there is a tendency to the oxidation of molybdenum(V) in a compound with $HSCH_2COOH$ to molybdenum(VI). The

selectivity of the reaction of molybdenum(V) with $HSCH_2COOH$ in a weak acid medium (in 0.3M HCl) is considerably higher than that of molybdenum(VI) at a pH of 3 to 5. But the sensitivity of the reaction is lower. A highly selective photometric method was developed for the determination of small amounts of molybdenum (1 to 40 γ/ml) in alloy steels. Vanadium, large quantities of titanium, rare earths, iron, copper, and tungsten do not interfere. (auth)

10909 COMPLEXOMETRIC TITRATION OF URANIUM (IV) WITH THORON AS AN INDICATOR. P. N. Paleĭ and Li-yüan Hsü (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). Zhur. Anal. Khim., 16: 51-6(Jan.-Feb. 1961). (In Russian)

The possibility of complexometric titration of uranium (IV), with thoron as an indicator, at a pH of 1.0 to 1.8 in the presence of a number of elements is shown. A method is suggested for the determination of uranium(IV) in tetrafluoride using aluminum ions to mask fluorine. (auth)

10910 DETERMINATION OF TRACES OF BERYLLIUM IN URANIUM BY A SPECTROGRAPHIC METHOD. P. N. Paleĭ and E. V. Bezrogova. Zhur. Anal. Khim., 16: 57-9 (Jan.-Feb. 1961). (In Russian)

A combined method is suggested for the determination of down to 10^{-6}% beryllium in uranium by chromatographic concentration and spectrographic determination. The experimental error was ±20%. (auth)

10911 PHOTOMETRIC DETERMINATION OF SMALL AMOUNTS OF URANIUM WITH BROMOPYROGALLOL RED. V. F. Lukyanov and E. P. Duderova. Zhur. Anal. Khim., 16: 60-2(Jan.-Feb. 1961). (In Russian)

A method for the photometric determination of uranium in ores with bromopyrogallol red was developed. (auth)

10912 AMPEROMETRIC TITRATION OF URANIUM (VI) WITH CHROMOUS SALTS. Z. A. Gallai and G. E. Kalenchuk (Moscow State Univ.). Zhur. Anal. Khim., 16: 63-7(Jan.-Feb. 1961). (In Russian)

A method was developed for the direct amperometric titration of uranium(VI) with a chromous salt solution with the use of both a rotating and a vibrating platinum microelectrode. Lead up to the ratio of U : Pb = 1 : 50 did not interfere, as well as zirconium and thorium up to the ratio of 1 : 1000. The method permitted the determination of uranium in the presence of iron(III). (auth)

10913 QUANTITATIVE METHOD FOR THE DETERMINATION OF URANIUM BY MEANS OF LUMINESCENCE IN PHOSPHATE SOLUTIONS. A. V. Davydov, T. S. Dobrolyubskaya, and A. A. Nemodruk. Zhur. Anal. Khim., 16: 68-72(Jan.-Feb. 1961). (In Russian)

A sensitive method was developed for the quantitative determination of uranium by means of luminescence in phosphoric acid solutions. The method includes the preliminary separation of uranium from extinguishing admixtures by complexing them with EDTA, the extraction of uranium with the tributyl phosphate solution in carbon tetrachloride (with calcium nitrate), followed by the re-extraction of uranium into the aqueous phase with the phosphoric acid solution. The uranium content was determined by the luminescence intensity of the re-extract obtained. (auth)

10914 USE OF SELENUREA IN ANALYSIS. COMMUNICATION 2. PHOTOMETRIC DETERMINATION OF RUTHENIUM AND OSMIUM WITHOUT SEPARATION BY MEANS OF SELENUREA, THE COMPOSITION AND STABILITY OF THE RUTHENIUM-SELENUREA COMPLEX. A. T. Pilipenko and I. P. Sereda (Kiev State Univ.). Zhur. Anal. Khim., 16: 73-8(Jan.-Feb. 1961). (In Russian)

The composition and stability of ruthenium-selenurea complex was studied. It was found that selenurea (R) forms a colored compound with ruthenium, exhibiting maximum absorbance at 760 mμ and having the component ratio $[Ru^{2+}] : R = 1 : 3$. The stability of the ruthenium-selenurea complex can be characterized by the following approximate value of the unstability constant: $K_{RuSem_3^{4+}} = ([RuR^{4+}]R^2/RuR^{4+}) = 10^{-2}$. A method was developed for the determination of ruthenium and osmium without separation. The method permits the determination of 2 to 60 γ/ml of ruthenium and equal amounts of osmium in the presence of all platinum metals except large quantities of palladium. (auth)

10915 COMPLEXOMETRIC DETERMINATION OF U^{IV} WITH ARSENAZO IN INDICATOR. A. E. Klygin, N. A. Nikolskaya, N. S. Kolyada, and D. M. Zavrazhnova. Zhur. Anal. Khim., 16: 110-12(Jan.-Feb. 1961). (In Russian)

A complexometric method for the determination of uranium based on its reduction to U^{IV} with formamidinesulfinic acid and titration with a complexone III solution in the presence of arsenazo-1 is described. The method is suitable for the determination of uranium in its salts, oxides, alloys, tributyl phosphate, and some other extracts. (auth)

10916 USE OF TITRATION METHODS WITH SHARP END POINTS IN STUDIES OF URANIUM(VI) COMPLEXES. P. N. Paleĭ and N. I. Udal'tsova. Zhur. Neorg. Khim., 5: 2211-15(Oct. 1960). (In Russian)

The reaction of ethylenediaminetetraacetic acid [complexon(II)] and its disodium salt [complexon(III)] oxidation by various acidifiers was studied. It was found that under certain conditions complexon(III) has a tendency to oxidize at a platinum anode. On this basis, a dead-stop end-point method is suggested for the complexometric titration of U(VI) by complexon(III). The results of the analysis (considering the coordinate number six inherent to uranyl ion) indicate the following uranyl compounds with EDTA: $Na_2[UO_2(H_3Y)_4]$, $(NH_4)_2[UO_2(H_2Y)_2]$, $(NH_4)_2[UO_2Y(H_2O)_2]$, and $(UO_2)_2Y \cdot 3H_2O$. These are obviously the members of a genetic series. Thus the dead-stop end-point titration method can be utilized in studies of complex formation processes in addition to analytical studies. (R.V.J.)

10917 A RADIOMETRIC METHOD FOR DETERMINATION OF MAGNESIUM OXIDE IN PORTLAND CEMENT. J. E. Howes, Jr. (Battelle Memorial Inst., Columbus, Ohio), C. T. Brown, D. N. Sunderman, M. Pobereskin, and P. Schall. p.66-73 of "Symposium on Applied Radiation and Radioisotope Test Methods. Special Technical Publication No. 268. Philadelphia, American Society for Testing Materials, 1959."

A radiometric method for the determination of MgO in portland cement was developed. Magnesium analysis was performed using the same basic method as outlined in the ASTM standards on cement in which the magnesium is determined by precipitation as magnesium ammonium phosphate. The only modification was that the phosphate was labeled with P^{32}. The difference in the radioactivity before and after precipitation was used as a measure of the amount of magnesium ammonium phosphate formed. Using this method the currently required steps of digestion, filtration, ignition, and weighing were eliminated. By this radiometric procedure a determination could be completed within 1 hr with an accuracy of within 1%. (M.C.G.)

General Inorganic and Physical Chemistry

10918 (BM-RI-5668) THERMODYNAMIC PROPERTIES OF THE COMBUSTION PRODUCTS OF GRAPHITE

AND OXYGEN IN IDEALIZED DUST FLAMES. Robert W. Smith, Jr., Edwin B. Cook, and Hans M. Cassel (Bureau of Mines, Washington, D. C.). 1960. 14p. (OOR-975.3)

Examples are given at atmospheric pressure and room temperature of composition profiles in an idealized oxygen-dust flame, with both mass and enthalpy being preserved. (auth)

10919 (GA-1730) CHEMICAL PROBLEMS IN ADVANCED GAS-COOLED REACTORS. L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 1960. 10p. Project No. 32. Contract AF(04-3)-314.

The chemical problems largely involve gas- and solid-phase chemistry where chemical reactions and physicochemical processes occur at elevated temperatures (~4000°F). The high temperatures require that the fuel bodies and moderator be made of refractory materials and may preclude the use of metal cladding. Areas of concern include reactor materials and primary coolant systems, where most of the problems involve mass transfer. Reactions are discussed which can lead to carbon transfer in a gas-cooled graphite reactor. Substantial mass transfer can be expected from gas-phase diffusion across a gap caused by equilibrium concentration shifts when the gap boundaries are at different temperatures. Reactions are discussed which show how coolant impurities can lead to fuel migration. Activated charcoal appears to be a most useful agent for removing volatile-fission-product activities from the reactor coolant. In regard to the minimization of high-temperature vaporization processes, the carbide–graphite systems appear better than the oxide systems because the fuel material carbides are less volatile than the oxides in the presence of graphite. The vapor pressures are tabulated for gas-cooled-reactor fuel materials. (B.O.G.)

10920 (GAMD-1496) BORON COMPOUNDS FOR USE AS BURNABLE POISONS. S. Langer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 1, 1960. 9p. Contract AT(04-3)-314.

The properties of zirconium borides as burnable poisons are reviewed and summarized. Zirconium diboride is currently the most promising material; however its reaction with graphite may cause some limitation of maximum fuel temperatures. A further limitation may result from ZrB_2–C eutectic formation. (T.R.H.)

10921 (GAMD-1670) KINETIC EFFECTS IN THE TRANSPIRATION METHOD OF VAPOR PRESSURE MEASUREMENT. Wayne E. Bell and Ulrich Merten (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 9, 1960. 21p. Contract AT(04-3)-164.

The kinetic effects in laminar flow assuming constant evaporation rate and in turbulent flow are discussed. Results are given for diffusion coefficient measurements at zero flow rate in equilibrium studies of the chlorine-palladium system. (B.O.G.)

10922 (HW-59408) CHEMICAL REACTIVITY OF URANIUM MONOCARBIDE AND URANIUM MONONITRIDE WITH WATER AT 100°C. H. W. Newkirk (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 26, 1959. 7p. Contract AT(45-1)-1350.

The reactions of uranium monocarbide and uranium mononitride with boiling water were studied. Results lead to the conclusion that uranium monocarbide powder reacts with boiling water to form uranium dioxide. Uranium mononitride is unaffected by heating in boiling water for 24 hr. (J.R.D.)

10923 (HW-64421) DENSITY AND HYDROGEN CONTENT OF URANIUM OXIDE CAKES AND SLURRIES. L. C. Amos (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 22, 1960. 9p.

The uranium density and water (hydrogen) content were determined for UO_2-H_2O, UO_2 with hydrocarbon oil, and UO_3-H_2O mixtures ranging from compact centrifuge cakes to dilute slurries. (W.L.H.)

10924 (KAPL-M-LM-1) REACTION RATE OF BORON CARBIDE AND ZIRCALOY-2. L. Moskowitz (Knolls Atomic Power Lab., Schenectady, N. Y.). May 15, 1959. Decl. Sept. 1, 1960. Contract W-31-109-Eng-52. 27p.

Zircaloy–B_4C reaction rates were studied in the temperature range of 1200°F by annealing powder compacts that had been hot coextruded and by measuring the resultant reaction zone. The results indicate that the process is diffusion controlled. A single process apparently controls the reaction from 1220 to 1550°F, and a change in the process occurs at 1650°F that significantly decreases the dependence of reaction rate on temperature. B_4C particle size and absorbed particle moisture were found to have no significant effect on the reaction. The annealing results were in agreement with reaction zone growth resulting from fabrication heat-treatment. Based on the measured results, a plot of volume reaction zone after rolling vs. B_4C particle size was obtained. (auth)

10925 (KAPL-M-MTB-1) METAL-WATER REACTIONS: A SELECTIVE LITERATURE SEARCH OF USAEC REPORTS. M. T. Barringer (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 9, 1961. Contract W-31-109-Eng-52. 7p.

Forty-seven references are included. (W.L.H.)

10926 (MRC-R-197) RECOVERY OF FLOW STRESS IN DEFORMED SINGLE CRYSTALS OF LITHIUM FLUORIDE. Technical Report No. 3. E. S. Machlin (Materials Research Corp., Yonkers, N. Y.). Nov. 30, 1960. 20p. Contract NONR-2432(00).

The time and temperature dependence of the flow stress in LiF single crystals was measured. The kinetics of recovery obeyed the relation suggested by Kuhlmann. A two-stage recovery was found. The low-temperature recovery obeyed an activation energy of 5250 ± 700 cal/mole. The high-temperature recovery followed an activation energy of 43,500 ± 6000 cal/mole. Based on observation of the presence or lack of motion of dislocations during recovery, a theory for the recovery process is suggested. The rate-determining step for low-temperature recovery is suggested to be the glide of nonconservative jogs along screw dislocations; that for high-temperature recovery is dislocation climb and the annihilation of jogs along edge dislocations. (auth)

10927 (NP-9842) ELECTRON SPIN RESONANCE STUDIES OF A WEAKLY COUPLED BIRADICAL. Technical Report No. 37. D. H. Anderson, H. S. Gutowsky, and R. B. Sandin (Illinois. Univ., Urbana). Nov. 29, 1960. 27p. Contract Nonr 1834(13).

Electron spin resonance, including its temperature dependence, was studied in several solid salts derived from $\alpha,\alpha,\beta,\beta$-tetrakis-(4-dimethylaminophenyl)-ethylene (I). The paramagnetism appears to result form thermal excitation to low-lying triplet electronic states in which the unpaired electrons are only weakly coupled. Excitation energies of 4.5 and 8.6 kcal/mole are found for the I-diiodide and the I-dinitrate, respectively, the former value being confirmed by an absolute intensity measurement. The line widths are only 1 to 3 gauss in the solids even though the concentration of free radicals is very small. It is suggested that the averaging out of hyperfine and electron dipole-dipole splittings results from delocalization of the unpaired

electrons and from exchange interactions that may be aided by the "diffusion" of the paramagnetic species that results from the thermal excitation and deactivation. This implies that the solids are semiconductors, which was found to be the case from resistivity as a function of temperature measurements on the I-diiodide, the stablest of the derivatives. (auth)

10928 (NP-9698) DEPOSITION OF ^{65}Zn AND ^{32}P-PHOSPHATE ON VARIOUS METALLIC AND NON-METALLIC SURFACES: Report No. 172/V. E. Herczyńska (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Sept. 1960. 35p.

The deposition of Zn^{65} and P^{32} phosphate on various surfaces was studied as a function of pH of solutions. Observed deposition behavior, together with previously obtained results, is explained on the basis of an ion-exchange process. (auth)

10929 (ORNL-3043) KINETICS OF THE CATALYZED OXIDATION OF HYDROGEN, CARBON MONOXIDE, AND METHANE BY OXYGEN IN A FLOWING STREAM OF HELIUM. C. D. Scott (Oak Ridge National Lab., Tenn.). Feb. 21, 1961. Contract W-7405-eng-26. 21p.

Data from kinetic tests on the oxidation by oxygen catalyzed by a fixed bed of Girdler G-43 platinum catalyst of hydrogen, carbon monoxide, and methane in a flowing stream of helium were empirically correlated to give reactor design equations for use in design of catalytic oxidizers for gas-cooled-reactor helium purification systems. A typical design for the EGCR purification system was a catalytic oxidizer with 3.77 cu ft of catalyst. All tests were made in a 2-in.-diameter reactor at an average temperature of 500 ± 25°C, a total pressure of 300 psia, mass flow rates of 0.066 to 0.225 g mole/cm^2/min, and contaminant levels of 0.219 to 2.00 vol.%. (auth)

10930 (RM-2401(RAND)) A PARAMETRIC STUDY OF CERTAIN LOW-MOLECULAR-WEIGHT COMPOUNDS AS NUCLEAR ROCKET PROPELLANTS. II. AMMONIA. F. J. Krieger (RAND Corp., Santa Monica, Calif.). July 31, 1959. Project RAND. 47p.

A study was made of ammonia as a propellant for nuclear-powered rockets. The study includes composition, thermodynamic, and mass flow equations. A summary is presented in tabular form of computed values of specific entropy, specific enthalpy, and molecular weights at various temperatures and pressures. A summary is also presented of computed values for the isentropic expansion of ammonia through a nozzle, assuming instantaneous chemical equilibrium, a mass flow-rate of 1000 g/sec, and an initial chamber pressure of 0.1, 1, 10, 100, and 1000 atm. (W.L.H.)

10931 (SCTM-256a-60(14)) VAPOR PRESSURES OF THE RARE EARTHS. L. C. Beavis (Sandia Corp., Albuquerque, N. Mex.). Dec. 23, 1960. 13p.

The vapor pressures vs. temperature data are presented graphically for yttrium, scandium, and the rare earths. (auth)

10932 (TID-6740) NUCLEAR RELAXATION AND DYNAMIC ORIENTATION IN HYDRATED CRYSTALS AT LOW TEMPERATURES (thesis). Technical Report No. 4 Olaf S. Leifson (California. Univ., Berkeley). Sept. 1, 1960. 109p. Sponsored by AEC and ONR under Contract Nonr 222(61)

Thermal relaxation and dynamic orientation of protons in single crystals of $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$ were studied in which a small fraction of La^{3+} is replaced by paramagnetic Ce^{3+}. An apparatus is described for simultaneously observing nuclear magnetic resonance (16 Mc/sec) and paramagnetic resonance (9400 Mc/sec) at liquid helium temperatures. The proton relaxation time, T_{1n}, is obtained from the observed exponential decay of the nuclear resonance signals at temperatures of 1.6 to 4.2°K and Ce^{3+} concentrations of 0.05 to 5%. For a fixed Ce^{3+} concentration, $T_{1n}^{-1} \propto T^7$. At a fixed temperature T_{1n}^{-1} is roughly proportional to the square of the Ce^{3+} concentration. The Ce^{3+} ion relaxation time, T_{1e}, is measured by observing the exponential change in the microwave paramagnetic resonance signals following a pulse from a magnetron oscillator. Within experimental error, T_{1e} is found to be independent of Ce^{3+} concentration and $T_{1e}^{-1} \propto T^{14}$ at 1.9 to 2.6°K. The relative values of T_{1n} and T_{1e} are discussed in terms of an intermediate case between two idealized models: direct dipolar interaction between Ce^{3+} ions and all protons; and dipolar interaction of a Ce^{3+} ion with only nearest protons, plus spin diffusion among the protons. The protons are dynamically polarized by strongly inducing the (forbidden) microwave transitions which simultaneously flip electron and proton spins. For 1% Ce^{3+}, T = 1.6°K, ν = 9400 Mc/sec, the proton polarization was enhanced 140 times the thermal equilibrium value, compared to the ideal theoretical value of 605. The magnitude and field dependence of the polarization is discussed in terms of a model in which homogeneous line broadening allows both forbidden and allowed transitions to be simultaneously induced. Evidence for a diffusion of proton polarization is provided by the observation of the characteristic time for build-up of the enhanced polarization. (auth)

10933 (TID-6974) THE USE OF RADIOISOTOPES IN THE STUDY OF MODIFICATIONS OF PLATINUM CATALYSTS. Annual Technical Status Report No. 1 covering the period April 1, 1959 to March 31, 1960. James A. Stainfield (George Inst. of Tech., Atlanta. Engineering Experiment Station). April 20, 1960. 32p. Contract AT(38-1)-202. Project No. A-446-1.

Two samples of Adam's platinum catalyst were standardized using benzoic acid as the acceptor of hydrogen in an acetic acid solution. Rates, in units of min^{-1}/g at 30°C, were 274×10^{-4} and 198×10^{-4}. By the use of the second of these two catalyst samples, mesityl oxide and cinnamaldehyde were hydrogenated. Results are reported. (W.L.H.)

10934 (URCL-9512) AN INTERFEROMETRIC STUDY OF ATOMIC MERCURY SPECTRAL LINES. Robert Berg (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1960. Contract W-7405-eng-48. 23p.

Optical conditions required for accurate measurement of atomic line shapes and relative line intensities with a Fabry-Perot interferometer are discussed. Measurements were made on the 5461 A line of three commercial mercury lamps. (auth)

10935 (CEA-tr-R-529) ETUDE DU MECNAISME DE TRANSFERT DES MICROQUANTITÉS DE CERTAINS ÉLÉMENTS DANS LES CRISTAUX D'UN ENTRAÎNEUR NON ISOMORPHE. (Study of the Mechanism of Transfer of Micro Quantities of Certain Elements in the Crystals of a Non-isomorphous Carrier.) I. V. Melikhov (Melikov) and M. S. Merkulova. Translated into French from Radiokhimiya 1, 633-6(1959). 10p.

In a study of the mechanism for the transfer of microquantities of elements in crystals of a nonisomorphous carrier, two systems were used: $NaCl-PbCl_2-H_2O$ and $NaCl-CdCl_2-H_2O$. It was shown experimentally that the processes for the formation of seeds in almost terminated during supersaturation, varying from 73 to 95% of the initial supersaturation. At this stage an enrichment of the solid phase by the mixture does not occur. The enrichment of the solid phase takes place during the augmentation of the constant number of seeds having critical dimensions. It was proven

that in the case of coprecipitation of a supersaturated solution of isotopes of lead and chlorine with NaCl crystals during an increase in the mixing velocity of the solution, the velocity of the crystallization coefficient is lowered. (tr-auth)

10936 (CEA-tr-R-1027) TENSION DE VAPEURS DU FLUORURE DE LITHIUM. (Vapor Pressure of Lithium Fluoride). A. M. Evseev, G. V. Pozharskaya, An. N. Nesmeyanov, and Ya. I. Guerassimov. Translated into French from Zhur. Neorg. Khim., 4: 2183-91(1959). 10p.

The measurement of the pressure of saturated vapors of solid lithium fluoride is reported. Measurement was made using the Knudsen effusion method in the temperature interval from 926 to 1052.5°K. Results are tabulated. Heat of sublimation was calculated as 58.27 kcal/mole. (J.S.R.)

10937 (CEA-tr-R-1044) RECHERCHES SUR LA CHIMIE DU POLONIUM. II. OBTENTION DU POLONIUM HEXAVALENT. (Investigations of the Chemistry of Polonium. Part II. Preparation of Hexavalent Polonium). A. G. Samartseva. Translated into French from Doklady Akad. Nauk S.S.S.R., 33: 506-9(1941). 9p.

The cocrystallization of hexavalent polonium with corresponding compounds of hexavalent tellurium was used to show the existence of hexavalent polonium. Lead and potassium orthotellurates were used as the tellurium compounds. The distribution of the polonium between the solution and the precipitate during cocrystallization with $PbTeO_4$ and $K_2TeO_4 \cdot 3H_2O$ was determined. In both cases the constant of distribution remained constant. The possibilities of the formation of mixed crystals of a new type or of abnormal mixed crystals and the elimination of polonium by adsorption were excluded. The experimental data thus showed that polonium is coprecipitated isomorphically with the salts of the orthotelluric acid, in which the tellurium is hexavalent. (J.S.R.)

10938 (CEA-tr-R-1058) DÉSORPTION DU STRONTIUM ET DU CÉSIUM RADIOACTIFS DES PARTICULES EN SUSPENSION DANS LES RÉSERVES D'EAUX À CIEL OUVERT. (Description of Radioactive Strontium and Cesium from Particles Suspended in Water Supplies Open to the Sky). L. K. Ponomareva and V. L. Zolotavin. Translated into French by B. De Trezvinsky from Radiokhimiya, 1: 619-21(1959). 10p.

An almost complete desorption of radioactive strontium from particles suspended in water reserves open to the sky can be obtained by treating the particles with 0.5N to 1.0N solutions of hydrochloric or nitric acid. The desorption of radioactive cesium is more difficult. Only boiling the precipitate with concentrated acids can produce 98 to 99% extraction. (tr-auth)

10939 (CEA-tr-R-1132) TENSION DE VAPEUR DU TETRAFLUORURE D'URANIUM. (Vapor Pressure of Uranium Tetrafluoride). M. M. Popov, F. A. Kostylev, and N. V. Zubova. Translated into French from Zhur. Neorg. Khim 4: 1708-9(1959). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 21388.

10940 (RAE-Lib-Trans-885) PREPARATION OF SINGLE CRYSTALS OF SILICON CARBIDE AND CONTROL OF THE FORM AND AMOUNT OF INCLUDED IMPURITIES. (Darstellung von Einkristallen von Siliciumcarbid und Beherrschung von Art und Menge der Eingebauten Verunreinigungen). J. A. Lely. Translated by H. C. Ranson from Ber. deut. keram. Ges., 32: 229-31(1955). 7p. (AD-236639)

Colorless hexagonal single SiC crystals were prepared by purification of SiC. Inclusions of group 3 and group 5 elements in the lattice produced crystals of deficient and excess conductivity, respectively. (C.J.G.)

10941 (SCL-T-344) MASS-SPECTROMETER DETERMINATION OF THE AMOUNT AND COMPOSITION OF GASES ADSORBED ON THE SURFACE OF GERMANIUM AND SILICON MONOCRYSTALS (EXCERPTS). (Opredelenie kolichestva i sostava gazov, adsorbirovannykh na poverkhnosti monokristallov germania i kremnia mass-spektrometricheskim metodom). V. M. Kozlovshaya. Translated by Marcel I. Weinreich (Sandia Corp. Albuquerque, N. Mex.) from Fiz. Tverdogo Tela, 1: No. 7, 1027-34 (1959). Excerpts: p. 1027, 8, and 9. 7p.

A study was made of the nature, the quantity, and the composition of gases released from silicon and germanium. The effects of etching (pickling) on the adsorption was also studied. It is shown that the mass spectrometer method is suitable for detailed studies of the adsorption properties of the surface of semiconductors. (auth)

10942 (UCRL-Trans-612(L)) PRODUCTION OF CRYSTALS FROM DECOMPOSABLE COMPOUNDS. Albrecht Fischer. Translated from Z. Naturforsch., 13a: 105-10 (1958). 21p.

Crystals with mixed homo-heteropolar bonds decompose at temperatures far below their melting points. A graphite tube oven for 40 kva is described. This oven operates up to 2500°C and 150 atm, making it possible to melt decomposable crystals. (auth)

10943 (UCRL-Trans-614(L)) COLLOIDAL RHODIUM. A. Gutbier and Edith Leuthusser. Translated by Felice Immergluck from Z. anorg. u. allgem. Chem. 149: 181-90 (1925). 12p.

Methods are described for preparing rhodium colloidal solutions by the action of hydrazine hydrate and protective colloidal agents. (W.L.H.)

10944 (UCRL-Trans-628(L)) CHEMICAL STABILITY OF BERYLLIUM BORIDES WITH RESPECT TO OXYGEN, NITROGEN AND CARBON AT HIGH TEMPERATURES. G. S. Markevich and L. Ya. Markovskii (Markovskiy). Translated by Richard B. Mudge from Zhur. Priklad. Khim., 33: 1008-12(1960). 9p. (Includes original, 5p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 18965.

10945 THE CONTRIBUTION OF OCTUPOLE FORCE TO THE VAN DER WAAL ATTRACTIONS. F. Berencz (Univ., Szeged). Acta. Phys. Acad. Sci. Hung., 12: 103-6 (1960). (In German)

In the investigation of the interactions of two helium atoms, it was established that the dipole-octupole energy is equal in order of magnitude to the dipole-quadrupole energy so that in approximation methods in consequent calculations both must be considered. (tr-auth)

10946 PRODUCTION OF THICK LAYERS OF THORIUM, NEPTUNIUM, PLUTONIUM, AND AMERICIUM. G. I. Khlebnikov and E. P. Dergunov. Atomnaya Energ. 9: 406-8(Nov. 1960). (In Russian)

Preparations of thick layers of Th, U, Np, Pu, and Am by electrolytic precipitation, mechanical deposition with admixtures of various organic substances, electrochemical replacement, and deposition from suspensions are studied. (R.V.J.)

10947 MEASUREMENT OF THE SPEED OF ULTRASOUND IN MOLTEN ALKALI METALS. Yu. S. Trelin, I. N. Vasil'ev, and V. V. Roshchupkin. Atomnaya Energ. 9: 410-11(Nov. 1960). (In Russian)

The pulse interferometer method was used in measuring the ultrasonic speed in sodium and eutectic Na–K at 700°C. Calculations show that sonic absorption in molten alkali

metals with the ratio of thermal conductivity coefficient to viscosity higher by the order of two than in water, acetone, and other liquids depends on the thermal conductivity. The contribution of α_r^1 (sonic absorption coefficient specified by the friction and thermal conductivity in molten metal) in the absorption coefficient of sodium at 100 to 700°C is 10 and 1.3%, and 23 and 1.5% in eutectic Na–K. It is also shown that ultrasonics can be efficiently used for testing construction material wetting by alkali metals. (R.V.J.)

10948 NUCLEAR MAGNETIC RESONANCE OF IRON-57 NUCLEI IN THE LOCAL FIELD OF YTTRIUM IRON GARNET. Claude Robert. Compt. rend., 251: 2684-6(Dec. 5, 1960) (In French)

The nuclear resonance of Fe^{57} was shown in the local field of each of the two magnetic sublattices of yttrium iron garnet. The resonance frequencies and the relaxation times were measured as a function of temperature. (tr-auth)

10949 ABSORPTION SPECTRA OF PROTACTINIUM IN AQUEOUS SOLUTION. R. Guillaumont, R. Muxart, G. Bouissières, and M. Haissinsky (Laboratoire Curie, Paris). J. chim. phys., 57: 1019-28(Nov.-Dec. 1960). (In French)

The absorption spectra in the ultraviolet range of Pa^{5+} in perchloric, sulfuric, or hydrochloric solution and of Pa^{4+} in sulfuric or hydrochloric solution were measured. In each medium they were determined for different acidities and various anion and protactinium concentrations. The evolution of the absorption maxima was followed as a function of time. An attempt at the interpretation of the most important observations is made. The absorption maximum toward the short wave lengths, between 208 and 217 mμ, which is found in all solutions of pentavalent protactinium, was chiefly associated with an electron transition of the grouping Pa = 0. (tr-auth)

10950 PROPERTIES OF LITHIUM HYDRIDE. I. SINGLE CRYSTALS. F. E. Pretzel, G. N. Rupert, C. L. Mader, E. K. Storms, G. V. Gritton, and C. C. Rushing (Los Alamos Scientific Lab., N. Mex.; Oregon State Coll., Corvallis; and Univ. of Florida, Gainesville). Phys. and Chem. Solids, 16: 10-20(1960).

Single crystals of optical quality LiH were prepared by slow crystallization of the melt under hydrogen gas at moderate pressure. Measured and reported values of the physical, thermal, chemical, and optical properties of LiH and LiD are compared to those of LiF and NaCl. These properties bear out the predominantly ionic nature of crystalline LiH. The optical properties of LiH differ from those expected by a comparison with the properties of the alkali halides or the other alkali hydrides. This difference is related to distortion and polarization effects on the hydride ion in the LiH crystal lattice. There is a tendency toward covalency which may contribute to the binding energy of crystalline LiH, and this also may be responsible for its somewhat anomalous behavior. (auth)

10951 THERMODYNAMIC PROPERTIES OF GASEOUS FRANCIUM HALIDES. K. S. Krasnov. Radiokhimiya, 2: 668-70(1960). (In Russian)

The thermodynamic properties of gaseous francium halide molecules and their heats of sublimation were analyzed. (R.V.J.)

10952 ON THE VOLATILITY OF FRANCIUM COMPOUNDS. K. S. Krasnov and G. A. Krestov. Radiokhimiya, 2: 671-4(1960). (In Russian)

The volatility of francium halides was measured at 300 to 1000°K. Francium fluoride, followed by iodide, is most volatile. The difference in francium and cesium volatility is at a maximum with iodides, and they are more conveniently separated by sublimation in this form. (R.V.J.)

10953 HEAT OF COMBUSTION OF BORON. G. L. Gal'chenko, A. N. Kornilov, and S. M. Skuratov (Moscow State Univ.). Zhur. Neorg. Khim., 5: 2141-7(Oct. 1960). (In Russian)

Various methods for determining the heat of combustion of boron are analyzed, and a method is suggested in which no auxiliary fuel is used. The unreliability of aqueous extraction of boron oxide from a melt containing unreacted boron is discussed, and the method of weighing of boron oxide formed in combustion is analyzed. The standard enthalpy of glassy boron oxide formed from crystalline boron and gaseous oxygen was $\Delta H_{form}\, B_2O_{glass} = -2.98.7 \pm 1.8$ kcal/mole. (R.V.J.)

10954 ABSORPTION SPECTRA OF TRIVALENT PLUTONIUM HALIDES. L. V. Lipis and B. G. Pozharskiĭ. Zhur. Neorg. Khim., 5: 2162-6(Oct. 1960). (In Russian)

The absorption spectra of trivalent plutonium fluoride, chloride, and bromide were studied at ~10,000 to 3400 A. Absorption spectra at −195.8° exhibited spallated lines in the crystalline field, forming a number of components (from 2 to 12) depending on the type of compound. Considerable variations in spectra were caused by crystallization water. No changes were induced by adsorbed or occluded water. (R.V.J.)

10955 COMPLEX PLUTONIUM TETRAVALENT SULFATES AND ALKALI METALS. L. V. Lipis, B. G. Pozharskiĭ, M. E. Pozharskaya, and V. V. Fomin. Zhur. Neorg. Khim., 5: 2190-2203(Oct. 1960). (In Russian)

The preparation and properties of complex Pu(IV) sulfates and alkali metals are described. Considerable variations are found among the absorption spectra of synthesized $Na_6Pu(SO_4)_5 \cdot H_2O$; $(NH_4)_6Pu(SO_4)_5 \cdot 2$ to $4H_2O$; $K_4Pu(SO_4)_4 \cdot 2H_2O$; $Rb_4Pu(SO_4)_4$; and $Cs_4Pu(SO_4)_4$. Some common features were found in the absorption spectra of the pentasulfate complexes with sodium and ammonium and in the absorption spectra of tetrasulfate complexes with potassium, rubidium, and cesium. (R.V.J.)

10956 ACID COMPLEX Ce(IV) AND U(IV) COMPOUNDS. V. A. Golovnya, L. A. Pospelova, and G. T. Bolotova (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 5: 2204-10(Oct. 1960). (In Russian)

New acido compounds of U(IV) and Ce(IV) were synthesized by using SO_4^{2-}, CO_3^{2-}, and $C_2O_4^{2-}$. It is postulated that the replacing acids can occupy one or two coordination places in the same compounds. According to the coordination theory, the compounds form genetic series with a constant coordination number of 8. Water participates as an equal additive and can fill the compounds up to the constant coordination number. Postulations on erratic heterodynamic bonding of acid replacements were confirmed by the synthesis of mixed complex U(IV) and Ce(IV) compounds. (R.V.J.)

10957 EFFECTS OF COMPLEXING OF U(IV) ON KINETICS OF OXIDATION IN SULFURIC ACID SOLUTION. E. A. Kanevskii and L. A. Fedorova. Zhur. Neorg. Khim., 5: 2216-19(Oct. 1960). (In Russian)

The kinetics of U(IV) oxidation in perchlorate, persulfate, and peroxide solutions was studied by using $KClO_3$, $(NH_4)_2S_2O_8$; and H_2O_2 oxidizers, and the effects of U(IV) complexing on the oxidation rate were determined. A strong influence of complexing was confirmed by showing that the activation energy in perchlorate media (where complexing is absent) is about half that in the persulfate media (~9 and 18 kcal/mole, respectively). It was also shown that $U(SO_4)_2$ and USO_4^{2+} participate in the oxidation process initiated by persulfate and perchlorate in sulfuric acid media. (R.V.J.)

10958 DISSOLUTION OF ZIRCONIUM AND HAFNIUM HYDROXIDES IN SODIUM HYDROXIDE SOLUTIONS. I. A. Sheka and Ts. V. Pevzgner (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 5: 2311-14(Oct. 1960). (In Russian)

The dissolution of zirconium and hafnium hydroxides in various concentrations of sodium hydroxide was studied, and it is shown that the solubility of zirconium hydroxide at 25°C is lower than that of hafnium hydroxide. The dissolution of zirconium hydroxide increases with increased alkali concentrations. The dissolution of hafnium hydroxide in sodium hydroxides at 11N to 12N reaches a maximum and then drops. The composition of the solid phase, separated from hafnium hydroxide and concentrated alkali (15N), is expressed by the formula $NaHf(OH)_6$. The formation of $Zr(OH)_5^-$ and $Hf(OH)_5^-$ was observed in solutions of 1N to 10N NaOH, whereas $Zr(OH)_6^{2-}$ and $Hf(OH)_6^{2-}$ were produced at higher NaOH concentrations. (R.V.J.)

Radiation Chemistry and Radiochemistry

10959 (AERE-C/R-2431) THE COLORATION OF POTASSIUM CHLORIDE BY RECOILING FISSION FRAGMENTS. D. A. Young (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1957. 13p.

Enhanced coloration of potassium chloride occurs along the tracks of recoiling fission fragments permitted to enter the crystal matrix. The rate and extent of F-center aggregation to produce M, R, and eventually, R′ centers are greater along these tracks than in the other regions of the crystal. (auth)

10960 (AERE-R-3462) A VACUUM ULTRA-VIOLET RADIATION SOURCE OF HIGH INTENSITY. PART I. SURVEY OF SOURCES, WINDOW MATERIALS AND METHODS OF DOSIMETRY. F. S. Feates, B. Knight, and E. W. T. Richards (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 15p.

A critical survey is made of means of producing vacuum ultraviolet radiation of high intensity. The most promising method appeared to be an inert-gas resonance lamp. Suitable window materials possessing high transmission of the radiation were investigated, and techniques are described for the preparation of very thin films of Al, Al_2O_3, and SiO. However, only massive windows of LiF proved sufficiently robust in use, and these set a lower wavelength limit to the lamp at 1065 A. Methods of measuring the radiation output are considered, and the use of the photolytic decomposition of CO_2, as well as a nitric oxide-filled ionization chamber, was chosen for the final source. (auth)

10961 (ARL-TR-60-325) THE PHOTOCHEMICAL DECOMPOSITION OF WATER. Ronald E. West (Physics, Engineering, Chemistry Corp., Boulder, Colo.). October 1960. 37p. Contract No. AF33(616)-6529, Project No. 7116, Task No. 70349.

Solutions of the perchlorate salts of several cations have been irradiated with the unfiltered radiation of mecury arc lamps to compare their relative abilities to sensitize the photochemical decomposition of water to hydrogen and oxygen. This reaction is potentially applicable to the utilization of solar energy if it can be carried out efficiently. The ceric, cerous, cupric, ferric, ferrous, manganous, thallic, and uranyl cations were irradiated using five different lamp-reactor systems. All but thallic and uranyl produced gas under the conditions used. Only ceric gave consistent qualitative and quantitative results when used in different lamps. The reasons for the inconsistency with the other cations are not clear. The cupric ion gave perhaps the most interesting results and warrants further study. Under the best conditions, cupric perchlorate produced both hydrogen and oxygen with a quantum yield about 10^3 times greater than the only previously reported value for the simultaneous evolution of both gases. The generally low quantum yields obtained under the conditions of this work indicate no immediate applicability of this reaction to the utilization of solar energy. (auth)

10962 (BMI-1495) RADIATION-INDUCED NITRATION OF HYDROCARBONS. Mary J. Oestmann, E. Jack Kahler, Garson A. Lutz, and John F. Kircher (Battelle Memorial Inst., Columbus, Ohio). Jan. 26, 1961. Contract W-7405-eng-92. 16p.

The nitric acid–cyclohexane and nitrogen dioxide–cyclohexane systems were investigated to determine the effects of γ radiation on the nitration of hydrocarbons. The major parameters studied were integrated radiation dose or duration of exposure, temperature, phase of the reactants, and nitric acid concentration. The major effort was devoted to determining the yields of nitrocyclohexane and other products from radiation exposures of up to 117-hr duration, corresponding to 1.7×10^7 rads at 60 to 140°C. The same spectrum of products is obtained in both irradiation and thermal experiments using either nitric acid or nitrogen dioxide as the nitrating agent. Product yields, particularly nitrocyclohexane, increased with exposures up to 65 hr, or 1.2×10^7 rads, but then tended to decrease. Gas production and yield of nitro products increased with temperature. Nitrous oxide is the major gaseous product. The yield of nitrocyclohexane was slightly higher in the liquid than in the vapor phase. Dilution of the nitric acid concentration in the reaction mixture reduced the yield of nitro products. The results obtained in this program showed that radiation has little, if any, effect on nitration reactions. Surface conditions, temperature, and homogeneity of reactants have a much greater influence on the rate of reaction than the presence or absence of ionizing radiation. (auth)

10963 (HW-63239) IONIUM (THORIUM-230) FOR RADIOISOTOPE PREPARATION—STATUS REPORT. E. A. Coppinger and C. A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 15, 1959. 35p. Contract AT(45-1)-1350.

The general prospects of several radioisotopes are reviewed; the special properties of U^{232} and Th^{228} are pointed out; and ionium (Th^{230}) and protactinium target materials are discussed from the standpoint of availability and chemical separations processes required for the preparation of U^{232} and Th^{228}. Outlines are given for potential schemes for the separation of U^{232} and Th^{228} from uranium milling process waste streams and from the irradiation products of Th^{230}–Th^{232} mixtures. The high heat generating rates of these potent α emitters make them especially suitable for primary consideration as heat sources for small thermoelectric generators. The exceptionally high α activity suggests their use in special neutron sources as Ra-Be sources, and they may have sufficiently high neutron generating rates to be in contention with some of the smaller research reactors and experimental neutron producers. (B.O.G.)

10964 (NAA-SR-4484) THERMO-PHYSICAL PROPERTIES OF IRRADIATED POLYPHENYL COOLANTS. R. H. J. Gercke and G. Asanovich (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 58p. Contract AT(11-1)-GEN-8.

Density, viscosity, and melting point were determined for five organic materials considered for use as organic reactor coolants. The properties were determined for irradiated coolants at 300 to 800°F and as a function of high boiler or polymer concentration in the range of 0 to 40 wt.%. Polyphenyl coolant mixtures studied include mixtures of ⅔ ortho- and ⅓ meta-terphenyl, mixtures of ortho-, meta-, and para-terphenyl known as Santowax-R, diphenyl, monoisopropyldiphenyl, and polyphenyl mixtures used as the coolant in the Organic Moderated Reactor Experiment (OMRE) mainly consisting of ortho- and meta-terphenyl with smaller quantities of diphenyl and para-terphenyl. All except the last coolant mixtures listed were irradiated in a circulating in-pile loop. The changes in the properties of these coolants are compared with the results of the OMRE (reactor) irradiation. (auth)

10965 (NP-9730) ON THE FORMATION OF H_2O_2 IN DEAIRATED AQUEOUS SOLUTIONS UNDER THE INFLUENCE OF Co^{60} RADIATION. THE INFLUENCE OF HYDRATATION ENERGY OF CATIONS ON THE AVERAGE YIELD OF THE INVESTIGATED PROCESS. Report No. 181/Chr. E. Wełranowski and S. Minc (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Oct. 1960. 21p.

The relation between the average yield of H_2O_2 in deaerated aqueous solutions and the hydration energy of cations added to the solutions from the viewpoint of Franck-Rabinowitsch "cage effect" was investigated. The following relation was obtained: $G = 1.2Q^{-0.29} - 0.062c$, where G = average yield of H_2O_2 (molecules per 100 ev), Q = hydration energy (kcal per mole), c = concentration of cations (M/l) in the range, 0.2M−1.0M. The concentration of mercury ions was found to be variable under the conditions of irradiation of the solutions. (auth)

10966 (NYO-2836) EFFECT OF IRRADIATION OF SOLID CATALYSTS. H. C. Andersen, G. Cohn, C. D. Keith, and P. N. Rylander (Engelhard Industries, Inc., Newark, N. J.). Sept. 30, 1960. Contract AT(30-1)-2402. 30p.

Precious-metal catalysts were irradiated with γ or β radiation and their activities redetermined. The reactions comprised seven types of hydrogenation in liquid phase, three gas-phase reactions, and, in a few cases, naphtha reforming. Gamma radiation (2.90×10^7 r) produced no measurable change in activity as indicated by any of these reactions. Beta radiation at the 200-megarad level yielded no activity change as measured by liquid-phase reactions. Gas-phase testing showed changes in activity in several instances. Some of these effects may, however, be due to other causes, but one catalyst appeared to be genuinely affected by irradiation. Catalysts consisting of palladium or platinum on NiO or ZnO showed apparent changes in activity. These changes appear specious since in a few instances it was shown that similar alterations could be induced by storing the unirradiated samples in dry ice, which had been used during and after irradiation to prevent thermal effects and annealing. A catalyst consisting of 5% palladium oxide on silica−alumina showed the following ratios of first-order rate constants: (1) $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ (25°C), r = 1.8−4.0; (2) $CO + \frac{1}{2}O_2 \rightarrow CO_2$ (124°C), r = 0.45−0.5; (3) $N_2O \rightarrow N_2 + \frac{1}{2}O_2$ (375 to 388°C), r = 0.40−0.55. The change in catalytic activity observed upon irradiation can also be induced by heat treatment in air. This finding, together with some evidence in the literature, suggests that irradiation may have no practical merits for metallic catalysts. (auth)

10967 (TID-11620) LOW ENERGY INVESTIGATIONS OF RADIATION CHEMISTRY. Technical Progress Report. Robert W. Kiser (Kansas State Univ., Manhattan). Jan. 16, 1961. 95p. Contract AT(11-1)-751.

A description of the features and operation of the Bendix time-of-flight spectrometer is presented, and its specific applications in these studies are summarized. Other information is reported from studies on ion-molecule reactions, electron impact studies concerning a number of small-ring heterocyclic compounds of nitrogen, sulfur, and oxygen, and some group IV alkyl organometallics and nitrogen oxides. In other work, results of a preliminary study of the neutron irradiation of hydrazine sulfate are reported. Research is reported on electron impact spectroscopy of tetra-methyl silicon, tin, and lead and ionization chamber counting of S^{35}. A compilation of atomic, molecular and radical ionization potentials is included. Also included are data on the electronegativities of selected radicals and molecules. (J.R.D.)

10968 (TID-11651) THE BETA DECAY OF C^{14} IN DOUBLY LABELLED ETHANE IN THE PRESENCE OF METHYL AMINE. Progress Report, January 1, 1960 to December 31, 1960. Alexander R. Amell (New Hampshire. Univ., Durham). Dec. 31, 1960. 34p. Contract AT(30-1)-1911.

The effects of dose, pressure of methyl amine, and pressure of ethane on the radiation-induced exchange of C^{14} between ethane and methyl amine are given. A mechanism explaining the results is postulated. The results of γ-induced decolorization studies of aqueous and alcoholic solutions of Orange IV are given. Results on γ indirect oxidation of stannous ions are included. (auth)

10969 (TID-11741) A COMPARISON OF RADIATION-INDUCED GRAFT COPOLYMERIZATION UTILIZING ELECTRON ACCELERATORS AND ISOTOPE SOURCES AS RADIATION INITIATORS. Progress Report for January 1961. (Radiation Applications Inc., Long Island City, N. Y.). Contract AT(30-1)-2636. 12p.

A project was initiated to investigate the basic mechanism of the grafting process via the determination of the relative reactivities of various monomers in graft copolymerization. The copolymer composition of methacrylic acid-styrene grafts on polypropylene film, Co^{60} and electron accelerator initiated, were analyzed by an infrared technique. The Co^{60} initiation resulted in a more constant molar ratio of methacrylic acid to styrene than did the accelerator initiation. The machine grafting of methacrylic acid-styrene to polypropylene film was found to have a less than half-order dependency on the dose rate when grafting was confined to total doses that did not generate heat during the irradiation. (auth)

10970 (WADD-TR-60-544) RADIOCHEMICAL PRODUCTION AND FATE OF FREE RADICALS. Roger E. Rondeau. (Wright Air Development Div. Materials Lab., Wright-Patterson AFB, Ohio). August 1960. 28p. Project No. 7360.

An effort is made to interpret and correlate to a limited extent, the many physico-chemical phenomena of radiation chemistry in terms of elementary free-radical processes. (auth)

10971 (AEC-tr-4409) ELECTRON PARAMAGNETIC STUDY OF RADICALS FORMED DURING THE HIGH ENERGY ELECTRON IRRADIATION OF POLYETHYLENE. A. T. Koritskii, Yu. N. Molin, V. N. Shamshev, N. Ya. Buben (Bulen), and V. V. Voevodskii (Voevodsky). Translated by J. Shabtai (Northwestern Univ.) from Vysokomolekulyarnye Soedineniya, 1: No. 8, (1959). 21p.

Observations of the EPR spectra of high-pressure polyethylene directly during the process of irradiation showed that at low temperatures (0 to −100°C) the formation of an alkyl radical of type I $[-CH_2-\dot{C}H-CH_2-]$ occurs, whereas

at high temperatures (~ +50°) the spectrum of an allylic type II radical $[-CH_2-\dot{C}H-CH=CH-CH_2-]$ is observed. The difference in the stabilities of radicals I and II points to a difference in the mechanism of their recombination and could serve as an indication of a possible easy migration of the free valency in the case of radical I. The stability of I increases with the increase of crystallinity of polyethylene and that could be connected with the decrease of freedom of molecular crystalline samples. The recombination of radicals accumulated during irradiation should play an essential role in the crosslinking process in polyethylene. (B.O.G.)

10972 (CEA-tr-R-1009) ACTION CHIMIQUE DES ATOMES RADIOACTIFS DE BROME DANS LA RÉACTION DU BR AVEC LES NEUTRONS DANS LES DÉRIVÉS HALOGÉNÉS DU MÉTHANE. (Chemical Effect of Radioactive Atoms in the Reaction of Bromine with Neutrons in Halogenated Derivatives of Methane). A. N. Nesmeyanov (Nesmeianov), E. A. Borisov, and I. Zvara. Translated into French by S. Szyszman from Radiokhimiya, 1: 325-35(1959). 23p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 5242.

10973 (NP-tr-554) SECONDARY REACTIONS OF Br^{82} AND Br^{80m} RECOIL ATOMS IN BROMOMETHANES. A. N. Nesmeyanov, E. A. Borisov, E. S. Filatov, V. I. Kondratenko, Tsieh-Hsyang Chang, K. Panek, and B. M. Shukla. Translated by E. W. Hooper (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment) from Radiokhimiya, 1: (6), 712-16(1959). 17p. (Includes Original, 3p.).

An examination was made of the stabilization process of Br^{82} and Br^{80m} recoil atoms in CCl_3Br, CCl_2Br_2, $CHCl_2Br$, CH_2ClBr, CH_2BrI, CH_2Cl-CH_2Br, and CBr_3NO_2 in relation to added bromine (iodine). Determinations were made of the differences in behavior of Br^{80m} and Br^{82} recoil atoms in the compounds CCl_3Br, $CHCl_2Br$, $CHClBr_2$, CH_2BrCl, and CH_2BrI. An hypothesis is introduced concerning epithermal ion-molecule reactions. The retention in CCl_3Br and CH_2BrI of Br^{80m} and Br^{82} was examined for the addition of nitrobenzene, p-nitrobenzene, benzene, and toluene. The results indicated that the dipole moments of the solvents influenced the stabilization for Br^{82} more than for Br^{80m}, and indirectly confirmed the existence of epithermal reactions proceeding via changed bromine atoms. The application of strong electrostatic fields has no effect, at least to 7 kev/cm, on the stabilization processes of the recoil atoms. (B.O.G.)

10974 (TIL/T.5122) THE EFFECT OF IONIZING RADIATION ON THE STRUCTURE OF POLYAMIDES. N. A. Slovokhotova. Translated from Doklady Akad. Nauk S.S.S.R., 127: 831-4(1959). 6p. (AD-241098).

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 21646.

10975 PHYSICAL PROTECTION AGAINST RADIATION. H. Izadian (Université, Paris). Ann. Phys., 5: 1615-28 (Nov.-Dec. 1960). (In French)

The effect of x radiation on water in the presence of oxygen was studied. The potassium permanganate method was used for the determination of the hydrogen peroxide formed. It was found that the nature of the tube containing the water to be irradiated, whether it was pyrex, quartz, or platinum, had no effect on the peroxide yield. Oxidation yield curves for water in the presence of air were established. These curves show very sharply the role of oxygen with respect to the shape and dimensions of the water container. It is shown that if the water irradiated by x rays is then exposed simultaneously to an ordinary incandescent light, the hydrogen peroxide yield is much less than that obtained in the absence of this supplementary radiation. (J.S.R.)

10976 RADIATION-INDUCED CHLORINATION OF BENZENE. L. A. Krasnousov, P. V. Zimakov, and E. V. Volkova. Atomnaya Energ. 9: 412-14(Nov. 1960). (In Russian)

The process of radiation chlorination of benzene was studied with the purpose of determining the feasibility of applying nuclear emissions in preparation of hexachloride. The tabulated effects of various initiating reactions on the hexachlorocyclohexane isomer content show that prepared hexachlorocyclohexane differs by α isomer content. With increasing radiation energy the content of α isomer increased from 63.7 to 83.5% while the content of γ isomer remained unchanged. In the case of β radiation the content of α isomer depends on the thickness of β-irradiated layer; with a 5mm layer it is 78.5% and with 40mm layer it drops down to 61%. In contrast to photochemical chlorination, radiation-induced chlorination takes place at a very low temperature in the solid phase. The yield of chlorination products increases with reduced temperature down to −80°C. The product containing 97 to 99% total hexachlorocyclohexane isomer forms at 40 to −80°C. At temperatures down to −80°C the content of γ isomer increases 17 to 18%; however, with further drop in temperature the isomer content diminishes. The results show advantages of radioinduced chlorination in comparison to the photochemical method although the content of γ isomer in chlorinated products was identical. The ionizing radiation produces products with higher α-isomer content (up to 83%) which can be more easily separated and have less offensive odor. High penetrability of radiation and large radioinduced chemical yield enable chlorination in small diameter metallic tubes with external irradiation and improvement of reactor efficiency with considerably smaller over-all dimensions. (R.V.J.)

10977 NEUTRON ACTIVATION ANALYSIS OF HALOGENS IN HIGH-PURITY SILICON. Tadashi Nozaki, Toshi Kawashima, Hideo Baba, and Hidemaro Araki (Electrical Communication Lab., Tokyo). Bull. Chem. Soc. Japan, 33: 1428-30(Oct. 1960). (In English)

A trace quantity of chlorine, bromine, and iodine was determined simultaneously by neutron activation analysis. By careful distillation of a solution containing the alkali-fused silicon, chromium(VI) oxide, and sulfuric acid, bromine and chlorine were distilled out separately, leaving iodine in the residual solution, which was then distilled out after adding oxalic acid. Most kinds of high-purity silicon contained more than 0.1 ppm of a halogen, which was used in the course of its purification process, and also two other halogens, though of a smaller quantity. (auth)

10978 HOT-ATOM CHEMISTRY OF RADIOCOBALT IN NITROAMMINE COBALT COMPLEX SALTS. Nobufusa Saito, Takeshi Tominaga, and Hirotoshi Sano (Tokyo Univ.). Bull. Chem. Soc. Japan, 33: 1621-2(Nov. 1960). (In English)

Seven ammine and nitroammine cobalt (III) nitrates and nitrites were irradiated for 1 to 6 hr in a reactor thermal neutron flux of $\sim 3 \times 10^{11}$ neutrons/cm^2/sec. After cooling for one day, the irradiated salts were dissolved in water and the Co^{60}-labeled species were separated. The results show substitution of ligand NH_3 groups by outer anions (NO_2^- or NO_3^-) for most of the salts; this is interpreted in terms of the salt structures. (D.L.C.)

10979 THE DISTRIBUTION OF RECOIL TRITIUM IN BENZOIC ACID. Jiro Okamoto (Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 33: 1629-30(Nov. 1960). (In English)

The distribution of recoil tritium from $Li^6(n,\alpha)T$ in benzoic acid was investigated. A mixture of benzoic acid and lithium carbonate was irradiated for 15 hr in a reactor flux of 2×10^{11} neutrons/cm^2/sec. After irradiation the tritium in the carboxyl group was removed, the benzoic acid was counted, and derivatives were prepared in order to determine the tritium distributions in the ortho, meta, and para positions by difference of counting rates. The replacement of hydrogen by recoil tritium is found to be dominant at the meta position, and it is concluded that tritium reacts in solids after being thermalized. (D.L.C.)

10980 STUDY OF DIFFERENT PROCESSES FOR THE PURIFICATION OF POLONIUM. Jules Pauly (Collège de France, Paris). Bull. soc. chim. France, No. 11-12, 2022-30(Nov.-Dec. 1960). (In French)

Different purification processes were studied and applied to activities of the order of a curie for the preparation of polonium by neutron irradiation of bismuth. The treatment is done in two steps. First there is separation of the more electropositive impurities, Fe, Be, and Pb, by spontaneous deposition on Ag, Cu, or Hg or by reduction with $SnCl_2$. The silver is then eliminated by precipitation of the polonium in ammoniacal solution. Finally solid sources easy to maintain are prepared by electrolytic deposition on gold foil. (tr-auth)

10981 THE EFFECT OF IONIZING GAMMA RADIATION ON THE STRUCTURAL-MECHANICAL PROPERTIES OF STARCH GELS. V. F. Oreshko, L. E. Chernenko, and N. G. Shakhova (Moscow Technological Inst. of Food Industry). Doklady Akad. Nauk, S.S.S.R. 134, 636-8(Sept. 21, 1960). (In Russian)

Samples of potato starch were subjected to Co^{60} γ doses of 1.0×10^6 to 18.2×10^6 r at a dose rate of 2000 r/min. The variation in plasticity of a standard gel with 12% dry starch was measured. Moderate amounts of radiation (1 to 3×10^6 r) caused an increase in the plastic strength of the gel, but larger doses (>4×10^6 r) caused a rapid decrease in the plastic strength. It is assumed that these changes in plastic strength are associated with changes in the number of hydroxy groups which promote the formation of a gel by hydrogen bonding. A series of relations is derived that include the dose, Avogadro's number, the energy necessary to disrupt a single bond, a factor for the number of hydroxyl groups formed in breaking a single bond, the average molecular weight of unirradiated starch, and the value of the plastic strength of the gel. The observed phenomena are explained satisfactorily in terms of an initial increase in the number of hydroxyl groups due to bond breaking whose rate varies linearly with the dose with a subsequent decrease in the number of hydroxyl groups due to depolymerization whose rate varies as the square of the dose. (TTT)

10982 CHEMISTRY AND RADIOISOTOPES IN A NUCLEAR RESEARCH CENTER. J. M. Fletcher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Energia nucleare (Milan), 8: 37-44(Jan. 1961). (In English)

The role of chemistry and of radioisotopes in nuclear research is described. The fields with which the chemist is mainly concerned are the study of processes of the production of materials used in reactors, the provision of isotopes of fissile material to determine nuclear constants of importance in reactors, the chemical problems confronted during the operation of reactors, and the processing of irradiated fuels, together with effluent treatment and waste disposal. Many interesting examples are reported, also concerning the contributions of reactors to chemical research and chemical industry. (auth)

10983 FREE RADICAL INDUCED REACTION BETWEEN FORMIC ACID AND PERDISULFURIC ACID. Edwin J. Hart (Argonne National Lab., Ill.). J. Am. Chem. Soc., 83: 567-71(Feb. 5, 1961).

The effect of formic acid and perdisulfuric acid concentrations and of pH and dose rate on the Co^{60} γ-ray initiated reaction of these compounds is reported. $G(CO_2)$ as high as 680 is found. The chain reaction proceeds with the stoichiometry given by: $S_2O_8^{2-} + HCOOH = 2HSO_4^- + CO_2$. $G(CO_2)$ increases with increasing formic acid concentration and with decreasing dose rate. At constant formic acid and perdisulfuric acid concentrations, $G(CO_2)$ also increases rapidly in the pH range from 1.5 to 5.1, but subsequently decreases at pH's in the range from 5.1 to 7 and again in the range from 9 to 11. The propagation steps proposed are: COOH (or HCOO) + $S_2O_8^{2-} = HSO_4^- + CO_2 + SO_4^-$ and $SO_4^- + HCOOH = HSO_4^- +$ COOH (or HCOO). Ionization of formic acid increases $G(CO_2)$, whereas ionization of the COOH and OH radicals explains the decrease in yield for the pH ranges of 5 to 7 and 9 to 11, respectively. Permonosulfuric acid and hydrogen peroxide add to the complexity of the reaction. Three briefly discussed additional radiation induced reactions of perdisulfuric acids show the stoichiometry: $S_2O_8^{2-} + H_2O = 2HSO_4^- + \frac{1}{2}O_2$; $S_2O_8^{2-} + H_2 = 2HSO_4^-$; and $S_2O_8^{2-} + H_2O_2 = 2HSO_4^- + O_2$ (chain). (auth)

10984 FORMATION AND IDENTIFICATION OF UNIQUE RADICAL SITES IN IRRADIATED AMIDES. E. J. Burrell, Jr. (E. I. Du Pont de Nemours & Co., Wilmington, Del.). J. Am. Chem. Soc., 83: 574-7(Feb. 5, 1961).

The free radicals produced in each of ten N-substituted amides by irradiation with 2-Mev electrons were characterized by their electron paramagnetic resonance spectra. A single species of radical is formed in each of nine of the amides. The G(radical) yield for N-(n-propyl)-propionamide is 4.7 ± 1.4. (auth)

10985 DIARYLALKANES AS HIGH TEMPERATURE, NUCLEAR RADIATION-RESISTANT HYDRAULIC FLUIDS. D. R. Wilgus, A. C. Ettling, and M. A. Pino (California Research Corp., Richmond). J. Chem. Eng. Data, 6: 106-11 (Jan. 1961).

A program to find organic compounds having good radiation resistance, thermal stability, liquid range, viscosity index, and other properties needed for hydraulic fluid applications was conducted. The α,ω-diarylalkanes were found to have these properties, and a large number was synthesized and screened as potentially stable hydraulic fluids. Among the tests made were thermal stability tests (heating to 700°F), irradiation to 5×10^{10} ergs/g carbon dose, oxidation-corrosion tests, and lubricating property tests. Correlations were made between molecular structure and physical properties and stability for unsubstituted α,ω-diphenylalkanes, alkylated diphenylmethanes, and substituted α,ω-diphenylalkanes. A hydraulic pump test was run on isopropyl-1,9-diphenylnonane. Diarylalkanes and other types of synthetic oils are compared with respect to their physical properties and stability. (D.L.C.)

10986 SYNTHESIS AND INVESTIGATION OF POLYNUCLEAR ALKYL-POLYPHENYL HYDROCARBONS AS POTENTIAL HIGH TEMPERATURE AND RADIATION-RESISTANT FLUIDS. Josef J. Schmidt-Collérus, John A. Krimmel, and George E. Bohner (Univ. of Colorado, Denver). J. Chem. Eng. Data, 6: 118-24(Jan. 1961).

The liquid range of thermally and radiation-stable polyphenyl compounds, e.g., biphenyl and terphenyl, can be widened by alkylation and isomerization of the phenyl nuclei. However, some sacrifices in other desirable properties, e.g., thermal and radiation stability, are also en-

tailed. An extensive study of the effects of various substituents on the properties of biphenyl and the terphenyls indicates that the best compromises between the desirable properties can be attained in the 3-heptyl-m-terphenyl and 4'-heptyl-m-terphenyl derivatives. A comparison is made between the alkylated polyphenyls and other radiation-resistant compounds, such as the polyaryl ethers. (D.L.C.)

10987 RADIOLYSIS AND MASS SPECTROSCOPY. Lydia Reinisch (Faculté des Sciences, Paris). J. chim. phys. 57: 1064-71(Nov.-Dec. 1960). (In French)

An attempt is made to find a relation between the nature and abundance of the fragments of an organic compound created by radiolysis and the corresponding mass spectrum. The experimental study was made on the radiolysis of gaseous alkanes in the presence of iodine. The basic hypothesis states that during the radiolysis and because of the relatively high pressures at which it occurs, the parent ion created by the radiation will not have the time to be decomposed according to the complete sequence of fragmentation to the extent that it can be detected in the mass spectra. (tr-auth)

10988 CHEMICAL EFFECTS OF IONIZING RADIATIONS ON AQUEOUS SOLUTIONS OF VANADIUM. III. EFFECT OF α PARTICLES ON ACID SOLUTIONS OF TETRAVALENT AND PENTAVALENT VANADIUM. J. chim. phys., 57: 1072-7(Nov.-Dec. 1960). (In French)

At sufficient doses the irradiation, by α particles from dissolved Po^{210}, of sulfuric acid solutions of tetravalent and pentavalent salts leads to a stationary state between these two valences, whereas the initial reduction of V^{5+} is accompanied by peroxidation. These various phenomena were interpreted by use of the hypothesis suggested in an analogous study with γ rays (J. chim. phys. 55: 772(1958)). The yields of radical and molecular products during the radiolysis of these solutions by 5.3-Mev α particles and the kinetic data on the reactions of the products with vanadium salts were determined. (tr-auth)

10989 THE THEORETICAL INTERPRETATION OF MASS SPECTRA. APPLICATION TO 1,3-BUTADIENE. J. C. Lorquet (Université, Liège). J. chim. phys., 57: 1085-9(Nov.-Dec. 1960). (In French)

The processes occurring during ionization and fragmentation of molecules bombarded by monoenergetic electrons are examined. The absolute calculation of a mass spectrum requires the solution of two problems: (1) calculation of the electronic levels of the ion and (2) study of the transition probabilities to each of these levels. Such a procedure must be completed by an assumption about the probability of rupture of the different chemical bonds in each electronic state. It is assumed that the chemical bond with lowest bond order will dissociate. The mass spectrum of butadiene is then calculated by this method using the electronic levels calculated by means of a LCAO/SCF/CI treatment and an empirical solution of the transition probability problem. (auth)

10990 EFFECTS OF γ RAYS AND OF DEGASSING ON THE ADSORPTION OF IONS IN AQUEOUS SOLUTION. J. Siejka and M. Haissinsky (Laboratoire Curie, Paris). J. chim. phys., 57: 1090-8(Nov.-Dec. 1960). (In French)

The adsorption of Ce^{3+}, Cs^{+}, and I^{-} from extremely dilute solution on various metallic surfaces and on polyvinyl chloride was measured. The effect of a preliminary treatment of the adsorbent, chiefly degassing, on the chemisorption of organic solvents and of irradiation with γ rays was examined. In some cases the effects of temperature and the kinetics of the phenomenon were also studied. Frequently the effect of the various factors on the adsorption of cations is exercised in an opposite sense to that observed for the adsorption of iodide. Degassing has a considerable effect on the adsorption of ions on platinum, but it is practically without effect in the case of the adsorption of I^{-} on stainless steel. Preliminary irradiation modifies equilibrium adsorption and the kinetics of the process. The adsorption heats and the activation energies were determined in some cases. The adsorption of Ce^{3+} on nonirradiated metallic adsorbents covered with a semiconducting oxide film is essentially of electrostatic origin, to which is added under the effects of irradiation a chemisorption. The adsorption of iodide is always of a chemical origin, and its importance varies with the constitution of the oxide film. An attempt at an exhaustive interpretation is given by utilizing the electron theory of adsorption. The Stern theory on the constitution of the double layer permits a calculation of some thermodynamic data that are in agreement with experimental values. (tr-auth)

10991 STUDY BY ELECTRON PARAMAGNETIC RESONANCE OF THE FREE RADICALS FORMED BY IRRADIATION IN THE IODIDE, BROMIDE, AND CHLORIDE OF CYCLOHEXANE AT 77°K. Karolina Leibler and Henri Szwarc (Faculté des Sciences, Paris). J. chim. phys. 57: 1109-10(Nov.-Dec. 1960). (In French)

Degassed samples of the iodide, bromide, and chloride of cyclohexane were irradiated under vacuum with γ rays at the temperature of liquid nitrogen. The spectra of the free radicals formed and the variations of the numbers of radicals as a function of temperature were studied by electron paramagnetic resonance. The measurements were made in the solid state in the temperature range between 86°K and the melting temperatures of the different compounds. In each case absorption spectra characterized by the presence of six rays were observed. At increased temperature the resolution of these spectra is improved. The recombination of the radicals occurs at different temperatures for the three compounds studied but in a very narrow range. The activation energy for the recombination was determined, and the results are tabulated. The radical yield for each compound was also determined. (J.S.R.)

10992 STUDY BY ELECTRON RESONANCE OF THE FREE RADICALS FORMED IN CYCLOHEXYL CHLORIDE BY IRRADIATION AT 77°K. EVOLUTION OF THE SPECTRUM OBTAINED AS A FUNCTION OF THE TEMPERATURE. Karolina Leibler (Laboratoire de Chimie Physique, Paris). J. chim. phys., 57: 1111-12(Nov.-Dec. 1960). (In French)

The free radicals formed by γ irradiation of cyclohexyl chloride under vacuum at 77°K and the spectrum obtained as a function of the temperature between 86 and 220°K were studied by electron paramagnetic resonance. At 86°K the spectrum has six rays with spacing corresponding to that found in the spectrum of irradiated cyclohexane. With increasing temperature an improvement of the rays is first observed, and then a better resolution is found. Above 159°K a doubling of the rays is found. Above 170°K the number of free radicals decreases, and a new variation of the spectrum form is detected. The spectrum varies gradually until 10 rays are observed. This transformation is irreversible. (J.S.R.)

10993 RADIOLYSIS OF POLYISOBUTYLENE IN STYROLENE SOLUTION. Jeanne Sebban-Danon (Faculté des Sciences, Paris). J. chim. phys., 57: 1123-9(Nov.-Dec. 1960). (In French)

The radiolysis of polyisobutylene in styrolene solution was studied. Two methods were utilized: interception by diphenylpicrylhydrazyl and interception by styrolene. In

this last method, the results from the study of the radiochemical grafting of styrolene on polyisobutylene can be used. It was found that styrolene exercises an important "protection" on polyisobutylene and that, during the irradiation, the polyisobutylene chain is broken into a macroradical and a small radical. (tr-auth)

10994 EFFECT OF NITRIC ACID ON THE REDUCTION OF CERIC IONS UNDER α RADIATION. Maria do Carmo Anta and Artur Marques da Costa (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Lisbon). J. chim. phys., 57: 1130-1(Nov.-Dec. 1960). (In French)

The radiolytic reduction of Ce^{4+} by α radiation was studied to compare the effect of nitric acid under α and γ irradiation and to determine the comparative effect of nitric and formic acids. The effect of nitric acid, with concentrations between 10^{-3} and 3M, on solutions 2×10^{-4} to 10^{-3}M in ceric ion and 0.4M in sulfuric acid was measured in the presence of air. The reduction yields are proportional to the dose regardless of the concentration of the nitric acid. For nitric concentrations above 2×10^{-2}M, the yield $G(Ce^{3+})$ (NO_3^-) increases with concentration for constant dose rates. Formic acid and Tl^+ have a sensitizing effect on the reduction of Ce^{4+}. The experimental data lead to the hypothesis of a direct effect of the radiation on the NO_3^- ions. (J.S.R.)

10995 PREPARATION OF LONG-LIVED TERBIUM-157 AND TERBIUM-158. R. A. Naumann (Univ. of California, Berkeley), M. C. Michel, and J. L. Power. J. Inorg. & Nuclear Chem., 16: 163–4(Nov. 1960). (In English) (UCRL-9287)

A 5-mg sample of dysprosium oxide enriched to 13.8% in Dy^{156} was irradiated with neutrons in the Materials Testing Reactor. The sample received an exposure of 2×10^{21} neutrons/cm^2 over a three-month interval. Four months after irradiation, mass analysis was made of the unseparated sample. The presence of mass peaks at 157, 159, 165, and 166, unobservable in the sample before irradiation, indicated neutron capture in Dy^{156}, Dy^{158}, and Dy^{164}. The samples were chemically fractionated, and scintillation spectroscopy revealed the presence of Ho^{165}, Dy^{159}, and Tb^{160}. Mass-spectrometric investigation of the terbium fraction revealed the existence of mass peaks at 157, 158, 159, and 160, indicating the preparation of new long-lived isotopes Tb^{157} and Tb^{158}. Calculations indicated that the K-capture half lives of these isotopes are greater than 30 and 15 years, respectively. (M.C.G.)

10996 THE MERCURY-SENSITIZED RADIOLYSIS AND PHOTOLYSIS OF METHANE. Gilbert J. Mains and Amos S. Newton (Univ. of California, Berkeley). J. Phys. Chem., 65: 212-17(Feb. 1961).

The radiation chemistry of methane at 260° using 4.5-Mev electrons was studied in the absence and presence of mercury vapor. The mercury-sensitized photolysis of methane at 260° and the radiolysis of methane at 25° were studied for comparison. The condensation products were analyzed by mass spectrometry and the yields of H_2, C_2H_4, C_2H_6, C_3H_8, iso-C_4H_{10}, n-C_4H_{10}, iso-C_5H_{12}, neo-C_5H_{12}, and neo-C_6H_{14} are reported in each case. The failure of mercury vapor to alter the product distribution by ion scavenging is taken as evidence for little contribution of ion–molecule reactions in methane radiolysis at 260°. The temperature coefficient of methane radiolysis was found too small to be accounted for in terms of thermal-free-radical reactions. A mechanism involving "hot" hydrogen atoms is proposed. A mechanism involving both ion–radicals and radicals also is consistent with the data. (auth)

10997 PREPARATION OF COPPER-64, NICKEL-65 AND MANGANESE-56 IN A HIGH SPECIFIC ACTIVITY. Hiroshi Ebihara and Kenji Yoshihara (Atomic Energy Research Inst., Tokyo). Japan Analyst, 9: 815-21(Oct. 1960). (In Japanese)

Preparation of some radioisotopes in a high specific activity was studied with the use of the Szilard–Chalmers effects of some metal oxinates (8-hydroxyquinolates). The experimental results obtained for copper, nickel, and manganese oxinates are given. Dehydrated oxinates irradiated in JRR-1 were dissolved in an organic solvent. The organic solution of oxinates was shaken with Michaelis' buffer solutions of various pH values. The extractability was calculated by comparing activities of both phases. On the other hand, the amount of metal in the aqueous phase was determined colorimetrically. Based on these values, each enrichment factor was determined. The results for copper showed that, after the organic solution was shaken with the aqueous solution having a pH of 11, the activity was about 9%, whereas the activity in 1.5N ammonium hydroxide solution was 15%. The enrichment factors obtained were 231 and 244, respectively. For nickel, about 81% activity was found in the aqueous solution of 0.5N sodium hydroxide solution, and an enrichment factor of 10^5 was obtained. Cobalt-58 produced by (n,p) reaction was separated from the nickel fraction by the ion-exchange method. Manganese ion was extracted with an aqueous solution of pH 8 to 9, whereas the oxinate was kept in the organic phase. About 10% activity was found in the aqueous solution after being mixed with the organic solution. The total amount of manganese was determined from the color of permanganate. An enrichment factor of 10^3 was obtained for Mn^{56}. (auth)

10998 ON THE ORIGIN OF THE COMPENSATION EFFECT IN THE RADIATION-INDUCED RADICAL RECOMBINATION IN POLYMERS. Ya. S. Lebedev, Yu. D. Tsvetkov, and V. V. Voevodskiĭ (Inst. of Chemical Physics, Academy of Sciences, USSR and Inst. of Chemical Kinetics and Combustion, SO Academy of Sciences, USSR). Kinetika i Kataliz, 1: 496-502(1960). (In Russian)

The available experimental data on the apparent reaction rate constants of the recombination of radicals in irradiated polymers show that there is a linear relationship between lg k^0 (the apparent reaction rate constant) and E (the activation energy). This phenomenon is called the compensation effect. Depending on the crystallinity of polytetrafluoroethylene (teflon), the values of k^0 and E vary over wide limits (E from 10 to 65 kcal/mole and k_0 from 10^{-18} to 10^{+6} cm/sec). If it is assumed that the activation energy decreases with increasing temperature, that is $k = k_0 \exp(-E(T)/RT)$, a set of equations can be derived that satisfactorily explain the large variation in the activation energy and the apparent reaction rate constant for irradiated polymers. (TTT)

10999 HEAT-SETTING OF NYLON 6 FIBER. VII. VISCOELASTIC AND THERMAL BEHAVIORS OF HEAT SET OR GAMMA-IRRADIATED NYLON 6 FIBER. Ako Koshimo (Nippon Rayon Co., Kyoto). Kobunski Kagaku, 17: 552-7(1960). (In Japanese)

In the heat setting of nylon 6 fiber, not only an increase in the degree of crystallinity but also a change of molecular spacing in the amorphous region may occur. Thus changes in viscoelastic and thermal behavior are expected. Samples were steam-set previously so that increase of crystallinity would not occur on subsequent treatments; steam or dry-heat settings and γ irradiation. From the results it was found that the intermolecular bonds were broken by

the steam setting and reproduced by the dry-heat setting reversibly. In the case of the γ irradiation, cross-linking was dominant in vacuum, whereas, in air degradation predominated. (auth)

11000 CHEMICAL STUDIES ON THE EFFECTS OF RADIATION ON POLY(VINYLALCOHOL). II. THE END GROUPS FORMED BY γ-IRRADIATION IN AIR OF DRY POLY(VINYLALCOHOL) POWDER. Ichiro Sakurada and Shuzi Matsuzawa. Kobunshi Kagaku 17: 689-93(1960). (In Japanese)

Dry polyvinylalcohol (PVA) powder was irradiated at room temperature in air with γ rays up to 9.0×10^7r. The scission of the main chain predominated although chain branching reactions also might have occurred. The G-value for the scission was 0.9. It was found that equal amount of the carbonyl and carboxyl groups were formed by the scission and increased with increasing dose. It appeared that the γ irradiation gave rise to one carbonyl group and one carboxyl group per molecule. Oxygen in air played a significant role in these radiation effects. (auth)

11001 CHEMICAL STUDIES ON THE EFFECTS OF RADIATION OF POLY(VINYLALCOHOL). III. THE END GROUPS FORMED BY γ-IRRADIATION IN VACUO OF DRY POLY(VINYLALCOHOL) POWDER. Ichiro Sakurada and Shuzi Matsuzawa (Kyoto Univ.). Kobunshi Kagaku 17: 693-7(1960). (In Japanese)

Dry polyvinylalcohol powder was irradiated in vacuo at room temperature with γ rays up to 1.1×10^8r. The scission of the main chain predominated as in the case of irradiation in air. The G-value for scission was 1.0. It was found that in this case the carboxyl and carbonyl groups were formed by the scission. The amount of these groups formed was much smaller than in the case of irradiation in air. The number of the two groups was equally 0.3 to 0.4 per degradated molecule. (auth)

11002 MODIFICATION OF POLYVINYLCHLORIDE. II. γ-IRRADIATION EFFECTS ON POLYVINYLCHLORIDE SOLUTIONS IN MORPHOLINE AND POLYVINYLCHLORIDE CONTAINING MORPHOLINE RING. Yoshiro Nakamura (Iwate Univ., Japan). Kobunshi Kagaku, 17: 721-4(1960). (In Japanese)

Gamma irradiation induces the substitution reaction between polyvinylchloride (PVC) and morpholine in solution. For example, the nitrogen contents of PVC irradiated in solution were about 2% when the total dose was 1×10^8 r. In this case, crosslinking also occurred between PVC molecules and the f value was found to be 0.1 to 0.2, which corresponded approximately to the value predicted from Charlesby's theory. Introduction of morpholine ring into PVC molecules accelerated gel formation by γ irradiation; for example, when the radiation dose was 3×10^7 r, the gel content was 70% for PVC containing 2.5% nitrogen, whereas the insoluble part was not found for pure PVC. Gamma irradiation on PVC containing morpholine ring was found to improve the dye ability of direct dyes to PVC. (auth)

11003 INFLUENCE OF CHEMICAL ISOMERISM ON THE SZILARD-CHALMERS PROCESSES IN SOLIDS. T. Costea and I. Dema (Inst. of Atomic Physics, Bucharest). Nature, 189: 478-9(Feb. 11, 1961).

A study was made of the difference in behavior of chemical isomers in radiocobalt annealing processes. Several cobalt complex combinations exhibiting different isomerisms were irradiated and the fraction annealed after irradiation was determined by separation of recoiled cobalt. Some qualitative observations are made. Chemical isomerism plays an important part in recombination of recoil fragments during irradiation. (T.R.H.)

11004 RADIOLYSIS OF CYCLOHEXANE. Shin Sato, Terumi Terao, and Shoji Shida (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 555-8(Apr. 1960). (In Japanese)

Many studies have been made on the radiolysis of cyclohexane by ionizing radiations but the systematic studies on the whole products including minor ones are comparatively few. In view of the situation a low-pressure gas chromatograph was made up to analyze quantitatively the minor gas products, and their initial G-values for Co^{60} γ-radiolysis were obtained as follows: H_2, 5.6; C_2H_4, 0.09; C_3H_6, 0.02; CH_4, C_2H_6, C_4H_8-1, n-C_4H_{10}, each 0.01; C_3H_8, C_2H_2, each 0.005; trans- and cis-C_4H_8-2, each smaller than 0.005. Cyclohexane, one of the liquid products, showed a remarkable decrease in its G-value with increasing radiation dose: for this product the initial G-value of 1.8 was obtained. (auth)

11005 THE RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. II. THE ^{60}Co-GAMMA-RAY, INDUCED ADDITION REACTIONS OF SEVERAL MERCAPTANS TO OLEFINS. Kunio Araki (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 807-9(May 1960). (In Japanese)

The Co^{60} gamma-ray-induced addition reactions of several mercaptans to olefins were carried out and the first-order rate constants of the additions were measured. Methyl-, n-butyl-, benzyl-, lauryl-, and phenyl-mercaptan added to vinyl acetate yielding β-methyl-(95.9%), β-n-butyl-(92.0%), β-benzyl-(96.2%), β-n-lauryl-(58.3%), and β-phenylthioethyl acetate (65.8%), respectively, and the first-order rate constants (10^{-2} min^{-1}) were found to be 7.0, 3.6, 1.3, 1.1, and 0.35, respectively. Allyl alcohol was also attacked by n-butyl-, benzyl-, and lauryl-mercaptan yielding γ-n-butyl-(97.2%), γ-benzyl-(93.3%), and γ-n-lauryl-thiopropyl alcohol (75.0%), respectively, and the first-order rate constants (10^{-2} min^{-1}) of the former two were 12.5 and 1.76, respectively, though the rate constant of the last could not be measured. Cyclohexene attacked by n-butyl- and benzyl-mercaptan yielded n-butyl-(92.6%) and benzyl-thiocyclohexane(89.0%), respectively, and also styrene attacked by methyl-mercaptan yielded ω-methyl thioethyl benzene (96.8%), and the first-order rate constants (10^{-2} min^{-1}) were 0.52, 0.76, and 0.49, respectively. (auth)

11006 CHANGES IN FLAVONOIDS INDUCED BY γ-RAY IRRADIATION. Takashi Mizuno and Tadao Kinpyo (Shizuoka Univ., Japan). Nippon Kagaku Zasshi, 81: 1143-8(July 1960). (In Japanese)

Ethanol or pyridine solutions of five flavonoids, i.e., myricetin, quercetin, quercitrin, rutin, and hesperidin, were irradiated with γ-rays (source Co^{60}). Results show that the decomposition of flavonoids increased with the increase of the total-dose γ rays (0.5 to 770 k. r.) and that glycosides such as quercitrin and rutin were more stable than aglycons, such as myricetin or quercetin. It was found that monosaccharides and aglycons, which are the components of glycosides, were formed by γ-ray decomposition of glycosides, such as quercitrin, rutin, or hesperidin, and that by the decomposition of aglycons such as myricetin or quercetin an unknown substance (showing its peak at 297 mμ in ultraviolet absorption spectra) was formed. Infrared absorption spectra of the substances produced by radiolysis from the above-mentioned flavonoids were compared with those of the flavonoids. (auth)

11007 REACTION OF ORGANIC LOW MOLECULAR COMPOUNDS BY COBALT-60 GAMMA-RADIATION. II. POLYMERIZATION OF STYRENE. Motome Hamashima (Government Chemical Industrial Research Inst., Tokyo). Nippon Kagaku Zasshi, 81: 1150-4(July 1960). (In Japanese)

Polymerization of styrene was carried out in the presence of an additive by irradiation of Co^{60} γ rays in vacuo at room temperature. A value of acceleration efficiency which depends on the kind of the additive, $R_E(R_E = R_P \times R_M$, where R_P is the ratio of the polymerization rate and R_M is that of the viscosity average molecular weight of the polymer with an additive and without it in the same experimental condition), is obtained from the results of the polymerization reaction. An additive which has two functional groups in the molecule is added to styrene monomer in a concentration of 0.1 mole/l. The additive, for example, when it has a halogen and a hydroxy group, only the hydroxy group shows an effect on the value of R_P, whether it is an aliphatic or an aromatic compound. An additive that has a functional group in the molecule is added to styrene monomer in the concentration range from 0.02 to 0.2 mole/l. Both the values of R_P and R_M change with the concentration of the additive, but the value of R_E is almost independent of the concentration of the additive except in the case of nitrobenzene. The values of chain transfer constant of the additives are also calculated. (auth)

11008 DESIGN AND OPERATION OF THE RADIOCHEMISTRY LABORATORY. PART I. G. R. Hall (Imperial Coll., of Science and Tech., London). Nuclear Energy, 59: 61-3(Feb. 1961).

An extensive discussion is presented on the factors involved in the design and operation of a radiochemical laboratory. The design considerations, e.g., level of work, air filtration, shielding, contamination of drainage system, and contamination control, are treated. Laboratories may be classed into one of three groups on the basis of Binks' radioisotope toxicity classification. The laboratories in a setup should be arranged in order of increasing levels of activity to minimize error in low-level radiochemical work. The design of a laboratory layout, with areas for offices, health physics, counting, etc., is finally considered. (D.L.C.)

11009 THE RADIATION INDUCED DECOMPOSITION OF POTASSIUM NITRATE. J. Forten and E. R. Johnson (Stevens Inst. of Tech., Hoboken, N. J.). Phys. and Chem. Solids, 15: 218-24(Oct. 1960). (In English)

Measurements of the heats of solution of irradiated KNO_3 indicate that a transition resembling a λ transition is induced in the solid at about 1 mole % decomposition. It is believed that this transition can account for the sharp decrease in the decomposition yield which occurs at about 1 mole % decomposition. In addition evidence is presented which indicates that the mechanism for the decomposition is molecular rather than by means of free radicals or other reactive species. (auth)

11010 COLOUR CENTRES IN X-IRRADIATED ALKALI METAL AZIDES. H. G. Heal and J. P. S. Pringle (Univ. of British Columbia, Vancouver). Phys. and Chem. Solids, 15: 261-9(oct. 1960). (In English)

Sodium, potassium, rubidium, and cesium azides, x-irradiated at liquid nitrogen temperature, develop F bands, other absorption bands at longer wavelength, ascribed to electron surplus centers, and V bands in the ultraviolet. At room temperature, sodium azide gives a broad band in the ultraviolet ascribed to photoemission by sodium metal; potassium develops two bands in the red ascribed to R centers. Cesium and rubidium azides develop broad-structured bands in the ultraviolet of undetermined origin. (auth)

11011 DYNAMIC MECHANICAL PROPERTIES OF IRRADIATED HIGH DENSITY POLYETHYLENES. E. Fukada (Imperial Coll. of Science and Tech., London), R. W. B. Stephens, and A. Charlesby. Phys. and Chem. Solids, 16: 53-9(Nov. 1960).

The dynamic Young's modulus and the mechanical damping of the low-density polyethylene (Alkathene) and the high-density polyethylene (Marlex 50 and Hostalen) subjected to electron irradiation were measured at a frequency of 0.2 c/s over a temperature range of 20 to 180°C. A remarkable change in the mechanical properties of irradiated high-density polyethylene was observed after heat treatment. After an initial heating of an irradiated specimen above its melting point, the elastic modulus at lower temperature decreases, and the curve of mechanical damping vs. temperature changes. Two peaks appearing in the damping vs. temperature curve may be associated with the melting process of two groups of small and large size crystals. The crosslinks introduced by electron irradiation at room temperature prevent the large crystals of polyethylene from regaining their original size after attaining the rubber state due to melting. The heat-treatment therefore produces a larger number of crystals of small size and fewer large crystals, which appears to conform with the tendency to an increase of height and width of the damping peak at lower temperature and a decrease of height of the damping peak at higher temperature. (auth)

11012 PARAMAGNETIC RESONANCE ABSORPTION IN SEVERAL ELECTRON-IRRADIATED MOLECULAR CRYSTALS. P. E. Wigen and J. A. Cowen (Michigan State Univ., East Lansing). Phys. and Chem. Solids, 17: 26-33 (Dec. 1960). (In English)

Paramagnetic resonance in a series of hydrated and deuterated molecular crystals irradiated with 1-Mev electrons at liquid air temperature was associated with a hole localized on the hydrogen-bonded oxygen of the oxyion group. In each case hyperfine structure due to the hydrogen bonding proton was analyzed with the aid of a hamiltonian containing an anisotropic term and an isotropic term and the results interpreted to give the relative position of the nucleus and the paramagnetic center. (auth)

11013 LIGHT SCATTERING BY NEUTRON IRRADIATED SILICA. R. D. Maurer (Corning Glass Works, Corning, N. Y.). Phys. and Chem. Solids, 17: 44-51(Dec. 1960). (In English)

The intensity of light scattered by fast-neutron-irradiated fused silica indicated that the damaged volume per primary struck atom is about $(67\ A)^3$. There is dissymmetry of scattering showing that this small volume was strung out in a long thin, or rodlike, region in order to give interference effects. The angular dependence of scattering for the $H_{||}$ and V_V components was different and could be accounted for by assuming that strain surrounds the damaged region. Theories of the strain scattering effect were developed to give a quantitative account of the scattering. These indicated how the angular dependence of scattering may be interpreted to discriminate between the effect of strain and the effect of the length of the rodlike regions. The length was found to be approximately 1800 A. (auth)

11014 INFLUENCE OF DISORDER ON THE LIFETIME OF POSITRONS IN ANTHRACENE. C. Cottini, G. Fabri, E. Gatti, and E. Germagnoli (Centro Informazioni Studi Esperienze, Milan). Phys. and Chem. Solids, 17: 65-8 (Dec. 1960). (In English)

The decay features of positrons in anthracene were experimentally investigated using both single- and polycrystals at temperatures ranging between −196 and 295°C. In solid specimens annihilation lifetime was equal to 3.7×10^{-10} sec, independently of the measuring temperature. A very notable effect was, however, found near the melting point (218°C), a complex decay appearing at about 210°C. Neutron-irradiated specimens showed a complex decay even at room temperature. (auth)

11015 (PARAMAGNETIC RESONANCE OF THE ANTIMORPH OF THE F-CENTER. Werner Känzig (General Electric Research Lab., Schenectady, N. Y.). Phys. and Chem. Solids, 17: 80-7(Dec. 1960). (In English)

LiF crystals x-rayed at 77°K and then warmed up to a temperature between 130 and 220°K contain a new kind of a trapped-hole center. Its electronic structure was studied by means of paramagnetic resonance. The center appeared to consist of a hole trapped at a lithium vacancy, and thus it may be considered as the "antimorph" of the F-center. However, the electron deficiency is localized on but two neighboring fluoride ions adjacent to the lithium vacancy, so that the symmetry is lower than that of the F-center. The new center is closely related to the self-trapped hole, as it can also be described as a F_2^- molecule-ion. However, owing to the vicinity of the lithium vacancy the molecular bond is "bent," so that the center has the symmetry of an isosceles triangle lying in a (0 0 1) plane with the base along a [1 1 0] axis. The thermal stability is higher than that of the self-trapped hole because of the Coulomb field of the vacancy. The main optical absorption band is probably centered at about 3400 A just as for the self-trapped hole. So far LiF is the only alkali halide in which a center of this type could be found. (auth)

11016 PARAMAGNETIC RESONANCE STUDY OF RADIATION DAMAGE IN LITHIUM FLUORIDE. Werner Känzig (General Electric Research Lab., Schenectady, N. Y.). Phys. and Chem. Solids, 17: 88-92(Dec. 1960). (In English)

The low-temperature annealing processes in LiF crystals x-rayed at 77°K were studied by means of paramagnetic resonance. Four types of hole centers (V-type centers), the structures of which are known from previous work, played an important part; namely, the self-trapped holes, the H centers, the V_F centers, and the V_1 centers. The relative concentrations of these defects were measured after x irradiation at 77°K and after subsequent pulse annealing at successively higher temperatures. Four temperature intervals were found in which the paramagnetic resonance spectra underwent significant changes in intensity. There seemed to be a one-to-one correspondence between the annealing processes observed by means of paramagnetic resonance and those detected by other investigators by means of thermoluminescence, conductivity, changes of the optical absorption, and of the crystal volume. (auth)

11017 SURFACE RECOMBINATION AND DIFFUSION PROCESSES IN CATHODOLUMINESCENCE AND ELECTRON BOMBARDMENT INDUCED CONDUCTIVITY. Gy. Gergely (Research Inst. for Telecommunication, Budapest). Phys. and Chem. Solids, 17: 112-16(Dec. 1960). (In English)

An analysis of the voltage dependence of cathodoluminescence and electron bombardment induced conductivity is given, taking into consideration the surface recombination and diffusion processes. The diffusion equation of DeVore was combined with Young's and Feldman's laws relating to the penetration and energy loss of incident electrons. A good agreement was obtained between the theoretical and experimental brightness vs. voltage curves. By the analysis of this curve the diffusion length L and the surface recombination velocity S may be determined. It was found that $L = 0.05-0.15\ \mu$ and $S = 5 \times 10^3-5 \times 10^5$ cm/sec for several phosphors. (auth)

11018 PARAMAGNETIC SCATTERING OF NEUTRONS BY RARE EARTH IONS. Simone Odiot and D. Saint-James (Centre d'Etudes Nucleaires, Saclay, France). Phys. and Chem. Solids, 17: 117-37(Dec. 1960). (In French)

The paramagnetic scattering of neutrons by rare-earth ions was studied. By using a method proposed by G. T. Trammel the crystalline field effects were taken into account. A means of direct determination is proposed for the level splittings of the ions. Experiments by W. C. Koehler and E. O. Wollan are discussed. The validity of the law $I \sim \sin^2 \beta$ (where β is the angle between the scattering vector and the magnetic moments) was examined. (auth)

11019 RESONANT ABSORPTION OF GAMMA RADIATION IN SUPERCONDUCTORS. P. P. Craig, D. E. Nagle, and R. D. Reiswig (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 17: 168-70(Dec. 1960). (In English)

Using the recently discovered resonance in the 77-kev γ level of Au^{197}, a search was made for effects influencing nuclear resonance absorption in the intermetallic superconducting compounds Au_2Bi and $AuNb_3$. Resonant capture of these 77-kev γ rays was observed by measuring their transmission through absorbing foils, first with the foil stationary and then with the source in motion relative to the absorbers. The results were consistent with the conclusion that no change in nuclear resonance absorption occurs in either Au_2Bi or in $AuNb_3$ as a result of the superconducting transition. (M.C.G.)

11020 CHANGES PRODUCED BY ULTRAVIOLET LIGHT IN THE PRESENCE AND IN THE ABSENCE OF OXYGEN ON THE PHYSICAL CHEMICAL PROPERTIES OF DEOXYRIBONUCLEIC ACID. Harold Moroson and Peter Alexander (Royal Cancer Hospital, London). Radiation Research, 14: 29-49(Jan. 1961).

Dilute solutions of DNA were irradiated with a mercury lamp in a quartz envelope that allowed radiations of low wavelength to penetrate, and with a filtered lamp with which the effects were due solely to light of 254-mμ wavelength. In the absence of oxygen, irradiation with the Vycor lamp reduced the viscosity and radius of gyration of the DNA. Initially there was no effect on the molecular weight, which fell only after a threshold period. Evidence from the absorption spectrum of the irradiated DNA and its stability at elevated temperatures suggests that the primary effect of 254-mμ light is to disrupt hydrogen bonds and thereby make the molecule more flexible so that it assumes a more coiled configuration in solution. In the presence of dissolved oxygen the rate of coiling by 254-mμ light is increased and main-chain scission (estimated from molecular weight changes) occurs immediately. With the unfiltered ultraviolet light both coiling and main-chain scission occur in the absence of oxygen. In its presence the number of breaks is greatly enhanced. The oxygen effect is probably due to the addition of oxygen to activated DNA to give a peroxide which is decomposed with the release of OH radicals. Hydroxyl radicals were shown to produce main-chain breaks but did not give rise to coiling. Ozone produced by short-wavelength ultraviolet light produces main-chain breaks relatively ineffectively. Decomposition products of ozone are probably the principal degradative agents when DNA is irradiated with the unfiltered lamp. Glutathione, dimethylaniline, and glucose (in relatively high concentrations) protect DNA against the effect of ultraviolet light in the presence of oxygen but not in the absence of oxygen. (auth)

11021 RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. A. J. Swallow. International Series of Monographs on Radiation Effects in Materials. Volume 2. New York, Pergamon Press, 1960. 392p. $15.00.

A comprehensive treatment of the radiation chemistry of organic compounds is presented. The following materials are treated: water, aqueous systems, aliphatics, aromatics,

polymers, dyestuffs, etc. The possible applications of radiation chemistry to other fields are considered. A bibliography of 1269 references is presented. (D.L.C.)

11022 METHOD OF PRODUCING NITROGEN DIOXIDE IN A NUCLEAR REACTOR. (to Rensselaer Polytechnic Inst.). British Patent 855,191. Nov. 30, 1960.

A method of producing NO_2 is given which consists of subjecting air or other nitrogen-oxygen mixtures to fission fragment recoil energy in a reactor. The optimum conditions for NO_2 production in this manner are pressures above 10 atm, temperatures between 175 and 225°C, and a reactor fuel consisting of enriched uranium or plutonium in a fine dispersion. The gas may be used to extract heat from the reactor before condensation of the NO_2 product and/or conversion into nitric acid. The inhibiting effect of the argon in air on NO_2 production must be taken into consideration. This method of NO_2 production is economical since, for a G value of 6, an amount of U^{235} worth $6,000 results in an amount of nitric acid worth $60,000. (D.L.C.)

11023 TREATING GAS-PHASE SYSTEMS. Davis Rich Dewey, II and Alfred John Gale (to High Voltage Engineering Corp.). British Patent 855,327. Nov. 30, 1960.

An improved method is given for bombarding a gas with high-energy charged particles, e.g., electrons, to induce chemical reactions and for other purposes. In this method, the absorption of the particles in the gas is greatly increased without need for large cumbersome apparatus by causing the path of the particles in the gas to curve into itself with a magnetic field. (D.L.C.)

11024 A RADIATION ALKYLATION PROCESS. (to Esso Research and Engineering Co.). British Patent 861,183. Feb. 15, 1961.

A method is given for the production of saturated branched-chain hydrocarbons using radiation. In this method, one or more saturated hydrocarbons having 2 to 12 carbon atoms/molecule is mixed with one or more monoolefins having at least 3 carbon atoms/molecule, and the mixture is exposed at 10 to 100 atm pressure to ionizing radiation to a total dose of 10^3 r. The mixture proportions should be 2 to 33 moles hydrocarbons to 1 mole olefins. This method of alkylation is superior to prior methods using photochemical reactions, high temperatures, high pressures, etc. (D.L.C.)

11025 METHOD FOR INDUSTRIAL RADIOCHEMICAL TREATMENT AND RADIOCHEMICAL REACTOR. (to Nobel-Bozel). British Patent 861,316. Feb. 15, 1961.

A radiochemical reactor is designed for treatment of solid, liquid, or gaseous substances on an industrial scale. The reactor comprises a plurality of channels arranged parallel to each other in which radioisotope cartridges of 10,000 to 2,000,000 curie activity are inserted and a plurality of conduits adjacent to these channels for continuous feed of the material that is to be irradiated. Several possible configurations of the reactor are shown. (D.L.C.)

Raw Materials and Feed Materials

11026 (MCW-1461) DE-ENTRAINMENT OF ORGANIC EXTRACT IN THE REFINERY BY ELECTROSTATIC PRECIPITATION. W. C. Philoon, A. H. Knebel, J. A. Soukup, and Patricia Fain (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Feb. 10, 1961. 7p.

Entrainment in organic extract can be reduced to ~ 0.003% by volume by electrostatic precipitation of aqueous and solid material. The low concentration of entrained material permits the routine production of UO_3 containing less than 0.5 ppm of vanadium. (auth)

11027 (NP-9795) MONTHLY REPORT [OF] DEVELOPMENT, DECEMBER 1960. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 29p. (D-60-12)

Atmospheric carbonate leach tests were made on low-sulfur flotation tails prepared from mill head samples. Results of these and two parallel tests show improved leaching with dispersed air. Results are also summarized from standard leach tests made on three samples of Beaverlodge ore. The caustic precipitation of sodium diuranate from Beaverlodge pregnant solution is discussed, and data from these tests indicate increased precipitation rates with the number of batches recycled. In other work, sodium carbonate was added to wet Beaverlodge ore and baked. Data show 53 to 60% U_3O_8 extraction by this method. In a study of sodium amalgam reduction of Beaverlodge barren solution, results of hydrolytic reduction and reductions in the presence of sodium hydroxide at various concentrations and with sodium bicarbonate are presented. In Port Hope refining activities, the solubility of silver chloride in sodium chloride was found to reach a solubility in salt solution of 350 g sodium chloride per liter. This may be applied in silver recovery from raffinate by raising the chloride high concentration enough to form silver chloride so that the silver can be separated by filtration or centrifugation. Examination of NRU flat samples from AR rolling reveals that β structures at high α rolling temperatures are more in evidence than those resulting from cold working at lower temperatures. Examination of photomicrographs of Type III rod samples was compared with samples prepared at Ottawa and showed both β and recrystallized structures, which were attributed to variations in heat treatment. Results of analysis of uranium–iron alloys obtained by direct melting of uranium metal and mild steel in the induction furnace are tabulated. In work on conversion of UF_6 to ceramic grade UO_2 by continuous precipitation, the product was found to be fluffy and subject to shrinkage. Development of a more suitable approach is in progress. Ammonium diuranate containing 1% NO_3 was processed into pellets. Most of the samples contained agglomerates which have acceptable microstructures and acceptable densities. (For preceding period see NP-9638) (J.R.D.)

11028 (NP-9853) A STUDY OF MERCURY-CATHODE MEMBRANE CELLS FOR THE ELECTROLYTIC REDUCTION OF URANYL SOLUTIONS. J. W. Kim and R. Simard (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Sept. 28, 1960. 36p.

Available as Can. Dept. Mines and Tech. Surveys, Mines Branch Research Rept. R 70. $0.25.

Bench-scale horizontal cation permeable-membrane cells were constructed to study the effect of cell dimensions on the efficiency of electrolytic reduction of uranyl sulfate solutions flowing continuously over a mercury cathode. Current efficiencies were determined for various cells having length-to-width ratios of 10 to 1 to 40 to 1, and for catholyte solutions containing from 20 to 100 g U_3O_8/liter in sulfuric acid. Optimum current density and solution flow rate were determined under these conditions. The effects of the nitrate and chloride ions were briefly examined. (auth)

11029 PURIFICATION OF URANIUM BY VERTICAL ZONE FUSION WITH ELECTRON BOMBARDMENT. Jacques Pascal and Paul Lacombe. Compt. rend., 251: 2709–11(Dec. 5, 1960). (In French)

The effect of the type of heating on the efficiency of zone fusion purification of uranium was investigated. Heating by hf induction was compared with electron bombardment heating. The thermal instability found in hf heating was avoided

in electron bombardment. The efficiency of electron bombardment heating was tested on two uranium samples. The purity of the metal was determined by a measurement of the electrical resistivity. The results are tabulated. (J.S.R.)

11030 THE MARY KATHLEEN URANIUM PROJECT. A. Nelson. Mine & Quarry Eng. 26: 94–101(March 1960).

A description is given of the treatment plant which can be considered to use an orthodox acid leach process. A diagrammatic flowsheet of the mill is shown. The following operations are described: crushing, fine grinding, leaching, counter-current decantation, clarification and ion exchange, precipitation, and reagent preparation. (B.O.G.)

11031 STUDIES ON TREATMENT OF URANIUM ORES. I. LEACHING OF URANIUM ORE FROM THE MATSUIWA MINE. Kingo Sudo and Akiichi Kigoshi (Research Inst. of Mineral Dressing and Metallurgy, Japan). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 332-8(Aug. 1959). (In English)

Studies were made of several processes of extracting uranium from the uraniferous ore of the Ryusei pit, Matsuiwa Mine, Miyagi Prefecture, assaying 0.081% uranium. Three series of experiments were carried out: pressure oxidation leaching of the uranium ore in carbonate solutions containing gaseous oxygen; leaching the roasted ore in sulfuric acid; and pressure and atmospheric oxidation leachings of the ore in acids. The results obtained showed that the atmospheric oxidation leaching with dilute sulfuric acid was an attractive method for extraction of uranium from such low grade ore. By this method over 96% of the uranium, together with some copper, and from 0.3 to 2% of the iron were extracted at 60°C in 6 hr. The same results were obtained with nitric acid. Atmospheric leaching in water with oxygen recovered over 80% of the uranium. (auth)

11032 STUDIES ON TREATMENT OF URANIUM ORES. II. RECOVERY OF URANIUM FROM LEACH LIQUORS OF A URANIUM ORE FROM THE MATSUIWA MINE. Kingo Sudo, Akiichi Kigoshi, and Noboru Masuko (Research Inst. of Mineral Dressing and Metallurgy, Japan). Sci. Repts. Research Insts., Tokohu Univ., Ser. A, 11: 411-17(Oct. 1959). (In English)

Each liter of acid leach liquors of a uranium ore from the Matsuiwa Mine contains 0.5 to 0.6 g of uranium as UO_2^{2+}, 2.2 to 2.3 g of Fe^{3+}, 1.4 to 1.7 g of Cu^{2+}, and 16 to 18 g of SO_4^{2-}. After some investigations, a columner ion exchange method was found to be the most adequate for the recovery of uranium from these liquors. By using an Amberlite IRA-400 resin column, adsorption-elution behaviors of the elements in these leach liquors were studied. Though the concentration of sulfate ion was too low to form uranyl-tri-sulfate anion complexes, its adsorption behavior was found quite desirable. By eluting it with a 0.9N NaCl–0.1N HCl solution, 7.8 g uranium/l uranyl solution was obtained, which contained iron in a ratio of less than 0.002 to the uranium concentration. Moreover, iron-free uranyl chloride solution, which contained 16.4 g of uranium/l, was obtained, by rinsing the uranium loaded ion exchange column with 8N HCl and eluting it with water. (auth)

11033 A PROCESS FOR THE PREPARATION OF URANIUM FLUORIDE. (to Junta de Energia Nuclear). British Patent 855,446. Nov. 30, 1960.

A simple method is given for producing UF_4 from ammonium uranate. In this method, gaseous ammonium fluoride or ammonium bifluoride is passed over ammonium uranate in an oven at 500 to 700°C for 1 to 2 hr. The reaction is $3(NH_4)_2U_2O_7 + 24\ NH_4F \rightarrow 6\ UF_4 + 21\ H_2O + 2\ N_2 + 26\ NH_3$. The gases issuing from the oven are treated to recover the ammonia and any ammonium fluoride. After the reaction is completed, an inert gas is passed into the oven for a few minutes to cool the product and to remove the ammonium fluoride residues. The advantages of this method are its simplicity, reduced time required for operation, no involvement of expensive or dangerous chemicals, and yields of ~99%. (D.L.C.)

11034 DIRECT INGOT PROCESS. (to U. S. Atomic Energy Commission). British Patent 860,141. Feb. 1, 1961.

A method and apparatus for the production of uranium ingots suitable for forging from UF_4 in a single-step magnesium reduction process in which highly purified carbon-free uranium is formed are described. The apparatus consists of an upper section formed of a hollow right frustum of a cone with a relatively large horizontal area, a lower section formed of a hollow right frustum of a cone, and an intermediate section to serve as an adapter between the upper and lower portions. A summary of 3300-lb ingot firing conditions and yields is included. The product has a low contamination of oxides, magnesium, and nitrogen. (M.C.G.)

11035 PREPARATION OF URANIUM TRIOXIDE. (to U. S. Atomic Energy Commission). British Patent 861,191. Feb. 15, 1961.

A method is given for preparing an improved form of UO_3 from aqueous solutions of uranyl nitrate. This form of UO_3 has increased density and granularity and, upon reduction with hydrogen, gives UO_2 of increased reactivity, especially in hydrofluorination to UF_4. This method consists of adding sulfur or a sulfur compound to the uranyl nitrate solution prior to denitration (concentration and calcination). The quantity of the sulfur compound added is best kept below 0.5 wt.% of the $UO_2(NO_3)_2 \cdot 6H_2O$. Conversions of 65 to 100% of the resulting UO_2 to UF_4 were obtained. (D.L.C.)

Separation Processes

11036 (AERE-R-3507) DEGRADATION OF DILUENTS USED WITH TBP IN SOLVENT EXTRACTION. B. O. Field and E. N. Jenkins (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1960. 27p.

The degradation of odorless kerosene and of a range of alternative diluents, in the presence of 20% TBP, by mixtures of nitric and nitrous acids at 60 to 70°C was investigated. It was established that the relative extent of degradation can be conveniently and reproducibly measured by a retention test using Hf^{181} as tracer. Alternatives to kerosene and fractions isolated from kerosene show greater resistance than kerosene itself to nitric acid. The purification of degraded solvent was studied. (auth)

11037 (BLG-51) TRAITEMENT DES SOLUTIONS DE PRODUITS DE FISSION SEPARATION DU CESIUM-137. (Treatment of Fission Product Solutions in Cs^{137} Separation). R. Stiennon-Bovy and R. Gvion (Brussels. Centre d'Etude de l'Energie Nucleaire). June 1, 1960. 28p.

Presented at "Conference sur l'emploi des radioisotopes dans les sciences physiques et dans l'industrie organisee par l'Agence Internationale de l'Energie Atomique, Copenhague, Septembre 6-17, 1960." (RICC/4)

For the industrial recovery of Cs^{137} from solutions of fission products, the analytical method for determination of cesium by dipicrylamine was used, adapting it to an industrial scale and to the high level of the activities encountered. The process makes it possible both to isolate cesium as a chloride and to recover the reagent in one and

the same operation. The effect of radiation on dipicrylamine and its compounds was studied, this effect proving to be practically nil for solid compounds and negligible for their solutions. The entrainment of cesium by ammonia ion was also studied. The advantages of the proposed process are outlined. By this process cesium can be recovered before certain fission products are eliminated. (auth)

11038 (CEA-1592) EXTRACTION DU PLUTONIUM PAR FORMATION DE SELS INSOLUBLES. (Plutonium Extraction by the Formation of Insoluble Salts). Michel Ganivet (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). June 29, 1960. 86p.

Thesis submitted to Conservatoire National des Arts et Metiers, Paris.

The conversion of Pu(IV) nitrate in solution into insoluble salts was studied. Three methods were studied: the conventional oxalic acid method, precipitation with 8-hydroxyquinoline, and adaptation of the hydrogen peroxide method to the eluates of ionic resins from Marcoule. The yield from the oxalic process was increased (loss of plutonium in the mother liquor decreased from 200 to 20 mg/liter). The study of Pu(IV) precipitation by 8-hydroxyquinoline showed that the yield is excellent (plutonium concentration in the mother liquor is <5 mg/liter), but decontamination from impurities is nil. Experiments on the precipitation of Pu(IV) by hydrogen peroxide solutions at the concentrations usually obtained from the anionic resins at Marcoule have given good yields (plutonium concentration in the mother liquor is <7 mg/liter). The purification is better than that obtained with oxalic acid (1000 ppm total impurities after a precipitation). (auth)

11039 (CF-60-2-11) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION B MONTHLY PROGRESS REPORT, JANUARY 1960. R. E. Blanco (Oak Ridge National Lab., Tenn.). Apr. 11, 1960. 57p.

The solubility of zirconium fluoride in HNO_3-NH_4F solutions was determined at 25°C. The solubility of $MoO_3 \cdot 2H_2O$ in 2 to 5M HNO_3 at 26°C decreased with increasing uranyl nitrate concentration. Dissolution rates of 95% ThO_2-5% UO_2 pellets decreased as the pellet density increased. It was determined that the gas evolved during the Zirflex Process was 1% H_2, 0.3% O_2, 0.2% N_2, and the rest NH_3. Uranium recovery from graphitized fuel specimens containing 0.7 and 5% uranium was accomplished by grinding and leaching with HNO_3. In the Zirflex Process, hot-cell experiments showed soluble plutonium and uranium losses to the declad solution of 0.05 to 0.08 and 0.01 to 0.11%, respectively. In dissolution of stainless-steel-clad UO_2 pellets by the Darex-Purex Process, uranium losses were less than 0.02% per cycle. Boildown curves for thorium nitrate-nitric acid solutions demonstrate that regardless of original composition the acid is not completely removed until the thorium is concentrated to about 1300 g/l. Corrosion studies were made on Ni-o-nel, Hastelloy F, and stainless steel in the Zirflex Process, on titanium in Thorex dissolver solutions, and on stainless steel in the Darex-Purex Process. Solubilities of uranyl dibutyl phosphate in HNO_3 and 30% TBP-Amsco-HNO_3 solutions were determined. Solvesso-100 was found to reduce radiation damage when used in place of Amsco 125-82 in TBP solutions. Addition of calcium as hydroxide or colloidal silicate to synthetic Purex 1WW waste prevented volatilization of sulfate. Greater than 99% of the cesium and strontium was removed from 667 volumes of low-level process water waste by passage through one volume of sodium-form Duolite C-3. The degree of ionization and total enthalpy of hydrogen and argon plasmas at one atmosphere were calculated for temperatures up to 20,000°K. (For preceding period see CF-59-12-74.) (M.C.G.)

11040 (CF-60-3-61) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, MARCH 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). May 31, 1960. 68p.

Vibratory compaction of ThO_2 in 3/8-in.-OD stainless-steel tubes with a pneumatic air-operated piston type vibrator gave densities from 8.7 to 9.0 g/cc. Thorium dioxide pellets, being developed for HR Blanket use, attained the highest densities when fired in an atmosphere of 75% N_2 and 25% CO. Thorium dioxide particles produced by flame denitration remained in the size range 1 to 2 μ when several different reflector temperatures and atomizing gas flows were tried. Four semicontinuous cyclic Sulfex declad and Thorex core dissolution of prototype Consolidated Edison fuel assemblies were made for determining reaction rates, dissolution rates, declad time, product loading, cross-contamination of the clad and core dissolvents and its effect on passivation and throium, and uranium losses to the declad solution. The mechanical equipment to dejacket the SRE fuel operated satisfactorily in initial mechanical tests. Commercial radiation protective coatings were evaluated under radiation up to 3×10^9 r. Vapor-liquid equilibrium data were obtained for boiling uranyl nitrate solutions. Detection of suspended granular dense solids is possible with a simple pneumatic density probe. Yankee Atomic flowsheet HETS values are reported for sieve and nozzle plates. A method of forming a bed in the horizontal section of a movable sodium fluoride bed for the volatility process was developed. A mathematical model was developed to describe the deposition of solids during the pot calcination of Darex waste. (For preceding period see CF-60-2-56.) (auth)

11041 (CF-60-3-74(Rev.1)) VOLATILITY PILOT PLANT—HAZARDS REVIEW REPORT. R. P. Milford, W. H. Carr, Jr., G. I. Cathers, R. W. Horton, S. Mann, F. W. Miles, J. B. Ruch, and C. L. Whitmarsh (Oak Ridge National Lab., Tenn.). July 26, 1960. 99p.

The ORNL Fluoride Volatility process for the dissolution of Zr-U fuel elements is described, and possible hazards and their control are discussed. The maximum credible accident is thought to be the destruction of cell off-gas filters by unreacted HF from the process or from the conversion of traces of unreacted F_2 to HF. A system for removing traces of HF or F_2 from the cell off-gas will be installed. The fast release of HF or F_2 at the outdoor supply stations is also considered credible. The use of recommended procedures for handling HF and F_2 as learned from the literature and experience should minimize the possibility of such releases. (auth)

11042 (CF-60-4-36) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION B MONTHLY PROGRESS REPORT, MARCH 1960. R. E. Blanco (Oak Ridge National Lab., Tenn.). 52p.

Consolidated Edison type fuel pellets were irradiated and analyzed, to determine the extent of fracturing, particle size of fines produced, and the rate of dissolution in boiling 13M $HNO_3-0.04$M $NaF-0.1$M $Al(NO_3)_3$. Fused sodium or potassium hydroxide was used to shatter the pellets at 400°C or higher. Similar pellets were dissolved in H_3PO_4 and fused ammonium bifluoride. An investigation was made of the thermodynamics and limits of flammability of gases expected during the dissolution of sodium-bonded stainless-steel-clad fuels in aqua regia or sulfuric acid. The amount of hydrogen evolved during Darex dissolution of 304 stain-

less steel was studied as a function of the fraction of total dissolving time and the total gas evolved. The rate of dissolution of tin in HF containing H_2O_2 was >10 mg/cm^2-min at 13 to 72°C, but decreased >10 times at 13°C when HF was replaced by NH_4F. A technique was developed for disintegrating and leaching graphite fuels, which yielded a recovery of 99.85% + uranium from fuels containing ~5% uranium. The uranium extraction in the Immi hot-cell facility indicated a 0.33% loss in the mixer-settler using the 6% TBP flowsheet. Yankee Atomic fuel, containing a fissia concentration of 10,000 Mwd/T uranium, was dissolved by the Darex and Sulfex Processes to determine the amount of acid insoluble residues formed. Solvent extraction studies revealed that thorium and uranium could be costripped from a 30% TBP neutral solution with $Al(NO_3)_3$. Distribution coefficients were determined for thorium and uranium in 30% TBP-Amsco systems. The presence of H_2O_2 in Zirflex dissolver solutions was found to decrease the corrosion rates of Hastelloy F, type 309 stainless steel, and Ni-o-nel. Palladium-titanium alloys showed somewhat higher corrosion rates than Ti-45A in Zirflex and fluoboric-nitric acid solutions. Specimens of type 304L stainless steel exposed to Darex-Purex waste solutions continued to show intergranular attack. The presence of borate in Thorex dissolver solutions lowered the corrosion rate of titanium in the solution phase, and eliminated pitting in the vapor phase. The radiation effects on di-sec-butyl phenylphosphonate were investigated. The distillation of degraded 30% TBP in Amsco 125-82 was tested for use in solvent repurification operations. The ruthenium volatility during the evaporation of wastes was reduced from 66 to 79% to 15% in the presence of TBP, and to 7 to 8% in a NO atmosphere, with or without TBP. A study was made of the nitrate-organic reactions taking place when Purex 1WW concentrates containing TBP were processed. A satisfactory method was found for solidifying Sulfex decladding solutions yielding blocks having compression strengths of 3000 psi. A hydroxyl-form strong-base anion exchange resin removed 72% of the gross fission product activity from low-level waste and raised the pH of the effluent water to 11.3. The Purex 1WW diluted waste was made 0.124M in oxalic acid, which increased the breakthrough capacity of Dowex 50 resin for strontium by 2 to 3 and for rare earths >3. Thermogravimetric and static studies were made of the kinetics of hydrogen reduction of $CaSO_4$. (For preceding period see CF-60-3-84.) (B.O.B)

11043 (CF-60-4-37) CHEMICAL TECHINOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, APRIL 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). July 28, 1960. 81p.

Experiments showed that 30% tributyl phosphate will not extract acid-deficient species of uranyl nitrate. Flooding throughputs for the Mark I stacked-clone contactor ranged from 600 cc/min organic at zero aqueous to 60 cc/min organic at 1950 cc aqueous. A large electronic vibrator of 5000-lb thrust was found somewhat inferior to pneumatic vibration for compacting oxide fuels into stainless-steel tubes. Tests were started on the use of fixed-bed CuO oxidizers for removing hydrogen contamination from helium gas streams. None of the variables studied within this period effected an increase in particle size in the denitration of thorium nitrate to produce ThO_2. The rate of uranyl sulfate loading on nitrate equilibrated Dowex 21K appears to be essentially independent of the loading solution sulfate concentration. The nitric acid concentrations corresponding to maximum UO_2-ThO_2 pellet dissolution rate were 15.5 M for Thorex solution and 13 M for the adjusted Darex solution. Two additional Semicontinuous Sulfex declad and Thorex core dissolutions of prototype Consolidated Edison fuel assemblies were made to complete the series of runs. The effective area of cylindrical UO_2 pellets dissolving in nitric acid was estimated from experimental rate measurements as a function of the fraction dissolved. A prototype SRE fuel rod was hydraulically expanded about 45 mils at 1300-psig pressure. Flooding capacities were determined for the compound extraction scrub columns with the acid Thorex flowsheet. A controlled cold-bath was installed for the condensation pressure analyzer to be used for UF_6 stream analysis. Tracer studies with the 8-in.-diameter by 84-in.-high waste calcination vessel showed the solid deposition pattern to be a radial growth from the side wall and a vertical growth from the bottom. (For preceding period see ORNL CF-60-3-61.) (auth)

11044 (CF-60-5-106) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION B MONTHLY PROGRESS REPORT, APRIL 1960. R. E. Blanco (Oak Ridge National Lab., Tenn.). 64p.

11045 (CF-60-7-76) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION B MONTHLY PROGRESS REPORT, JUNE–JULY 1960. R. E. Blanco (Oak Ridge National Lab., Tenn.). Dec. 12, 1960. 69p.

The effect of two neutron poisons, baron and cadmium, on the rate of dissolution of high-density 95% ThO_2-5% UO_2 pellets in the Zirflex Process was determined. Dissolution of U-10% Mo alloy in boiling HNO_3 resulted in a precipitation of uranyl molybdates. Air caused greater uranium and thorium losses during decladding of ThO_2–UO_2 fuel than irradiation. Processing of U–Mo fuel by a Zircex type process is discussed. Two leaches of graphitized fuel with 90% HNO_3 recovered more than 99% of the uranium. Irradiation of synthetic ThO_2 – UO_2 fuel solution to 5 and 10 watt-hr/l in a Co^{60} source resulted in about a 50% decrease in decontamination factor using the acid-Thorex flowsheet. Corrosion of titanium, tantalum, and Ni-o-nel in Thorex solution and titanium corrosion in various molybdenum core alloy solutions were investigated. The solubilities of ferric mono- and dibutyl phosphates in HNO_3 and 30% TBP-Amsco-HNO_3 solutions were determined. Fission product concentrations expected in Purex waste from processing Yankee Atomic Reactor fuel were calculated. Chemical applications of nuclear explosions to H^3 exchange, reduction of $CaSO_4$, and Gnome sampling are discussed. (For preceding period see CF-60-6-108.) (M.C.G.)

11046 (CF-60-8-86) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, AUGUST 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Dec. 15, 1960. 56p.

An apparatus was designed to permit visual observation of second-phase formation in flowing uranyl sulfate solutions at HRT temperature and pressure. Data on the vibratory compaction of oxide fuels were correlated using two-size fraction data to predict three-size fraction performance. The kinetics study of catalytic oxidation of hydrogen with Girdler G-43 catalyst for use in the GCR coolant purification system was completed and data were correlated. By the dissolution of Zircaloy-2 in NH_4F-NH_4NO_3 mixtures, room-temperature stable solutions were produced. Clarification of dissolver solutions studies showed that a steam jet-hydroclone system was effective for separating particulate UO_2 from siliceous waste solids. Excessive foam previously encountered in the leaching of UO_2 from chopped stainless-clad fuel elements was avoided by using cold acid

and no mercury catalyst. HETS values were determined as a function of cartridge design and continuous phase for both thorium and uranium stripping in the acid Thorex flowsheet. Sodium sulfate and sodium hydroxide were added to simulate Purex waste, yielding a solid in the calciner vessel, which melted at ~750°C. An experimental wetted-wall tower was constructed with provisions for introducing a sampled aerosol and for regulating the temperature of the water phase for studying directly the phenomenon of the growth of soluble aerosols. (For preceding period see ORNL CF-60-7-46.) (auth)

11047 (CF-60-9-43) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, SEPTEMBER 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Jan. 27, 1961. 55p.

Measurements of the interfacial tension between water and tributyl-phosphate solutions were made for application in the analysis of the Marengoni effect in solvent extraction. A 24-hr flame calcination run to produce ThO_2 particles yielded 40% as product, and 54% was collected from the furnace walls and from a coarse particle trap. The elution rates of uranyl ion from Dowex 21K using sodium nitrate could be approximated by assuming apparent diffusion coefficients of 1.67×10^{-7} and 1.18×10^{-7} cm^2/sec, respectively, for 960μ and 820μ resin, whereas the corresponding apparent coefficients using sodium chloride were 1.78×10^{-7} cm^2/sec. The reacting surface of ThO_2 pellets was determined as a function of fraction dissolved. The lead screws and companion nuts from both the multipurpose saw and dejacketing machine were coated with a baked-on lubricant. In Zirflex decladding studies using 4.5M NH_4F–0.5M NH_4NO_3, the average dissolution rate of Zircaloy-2 was decreased only 10% when the overhead condensate was withdrawn and 1.0 M NH_4OH was added to maintain the volume. Flooding rates were determined for both extraction and stripping pulse columns under 5% TBP flowsheet conditions. A condensation pressure analyzer and a gas density detector were examined for providing a continuous UF_6 analysis of the exit stream of absorber experiments. The average dissolution rate of Zircaloy-2 in molten salts was shown to have a logarithmic dependence on HF feed rate and a power dependence on kinematic viscosity. A calcination experiment was carried out using simulated Darex waste with additives to cause melting of the solid phase. (For preceding period see ORNL CF-60-8-86.) (auth)

11048 (CF-60-12-14) FISSION PRODUCT RELEASE FROM UO_2 BY HIGH TEMPERATURE DIFFUSION AND MELTING IN HELIUM AND AIR. G. W. Parker, G. E. Creek, and W. J. Martin (Oak Ridge National Lab., Tenn.). Feb. 14, 1961. 53p.

Experiments on the oxidation of UO_2 to U_3O_8 in air were found to result in the release of a large portion of the volatile fission products, although some anomalous behavior was exhibited in the temperature region of 600 to 900°C. Melting studies performed in helium and in air yielded similar, nearly quantitative, releases of Xe-Kr, iodine, tellurium, ruthenium, and cesium. Particles obtained from the vapors were composed of 0.02- to 0.2-μ-diameter crystals of U_3O_8 from melts obtained in air and of 0.0075- to 0.03-μ spheres of UO_2 from melts obtained in helium. High-temperature out-of-pile diffusion studies on sintered UO_2 compacts in high-purity flowing helium yielded rare-gas release rates similar to those obtained by other experimenters with vacuum type anneals. The energy of activation obtained from an average of all helium-diffusion experiments is 70 kcal/mole. Simultaneous measurements of the release of the principal fission products showed that two to three times as much iodine and tellurium diffuse out of UO_2 in helium as do the rare gases. Cesium and ruthenium diffuse somewhat less than the rare gases, and strontium diffuses much less than the rare gases. (auth)

11049 (CF-61-2-3) PROCESSING OF BERYLLIUM OXIDE FUELS. K. S. Warren and L. M. Ferris (Oak Ridge National Lab., Tenn.). Feb. 13, 1961. Contract W-7405-eng-26. 10p.

Preliminary results from experiments on the dissolution of beryllium metal and sintered UO_2–BeO fuel pellets are reported. Uranium, from UO_2–BeO pellets containing more than 60% UO_2, is readily leached with boiling 6 to 13M HNO_3 in ~6 hr. The BeO in these pellets dissolves only slowly in HNO_3; however, in 8M HNO_3–0.2M NaF it dissolves at about the same rate as the UO_2. Sintered pellets containing less than 10% UO_2 do not dissolve rapidly in common aqueous reagents. The highest rates are obtained in boiling acidic fluoride solutions; e.g., sintered BeO and BeO-8% UO_2 dissolved initially at a rate of ~1.7 mg/min cm^2 or 13 mils/hr in boiling 5.8M NH_4HF_2. Sintered BeO dissolved at an average rate of 5 mils/hr by bubbling HF through molten 49 mole % NaF-40 mole % LiF-11 mole % BeF_2 at 600°C. (auth)

11050 (DP-509) RECOVERY OF RARE EARTH FISSION PRODUCTS FROM PUREX WASTE. William E. Prout and Ernest K. Dukes (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1960. 16p. Contract AT(07-2)-1.

The precipitation of the rare-earth fission products as double sulfates was shown to be a satisfactory primary step in their recovery from concentrated Purex wastes. The method recovers about 90% of the desired rare earths, concentrated from the Purex waste by a factor of 200 and moderately well separated from other fission products. (auth)

11051 (HW-66386) CALCULATED EQUILIBRIUM DISTRIBUTIONS FOR THE URANYL NITRATE–TRIBUTYL PHOSPHATE–DILUTE NITRIC ACID SYSTEM FOR TEMPERATURES BETWEEN 25 AND 75°C. N. P. Wilburn (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 12, 1960. Contract AT(45-1)-1350. 41p.

The mechanism of extraction of uranyl nitrate into a 30% TBP hydrocarbon organic phase was assumed to be the following: $UO_2^{2+} + 2\,NO_3^- + 2\,TBP \rightleftharpoons UO_2(NO_3)_2 \cdot 2\,TBP$. From the data obtained, a value of enthalpy change for the reaction was computed for zero nitric acid concentration, assuming that this enthalpy change was independent of temperature. The uranium distributions for several temperatures between 25 and 70°C were then calculated for nitric acid concentrations between 0 and 0.3M. The calculated equilibrium distributions agreed reasonably well with the reported experimentally determined distributions. A standard deviation of 0.0056 mole per liter was obtained over the above range upon comparison with 11 experimental points. (auth)

11052 (HW-66562) NPF MECHANICAL CELL NaK DISPOSAL AND FUME ABATEMENT. G. Rey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 6, 1960. 14p. Contract AT(45-1)-1350.

Some of the fuels originally scheduled for processing in the nonproduction fuel (NPF) processing program incorporated sodium or sodium-potassium alloy (NaK) as the bonding material between stainless-steel cladding and the uranium or uranium-molybdenum alloy core. Because of the

special hazards involved in handling NaK, studies were made to determine safe methods for processing NaK-containing fuels. An underwater NaK dispensing system was installed, and tests were made to determine the characteristics of the NaK-water reaction. The equipment consisted of a dispenser, reaction pan, and off-gas scrubber. After initial studies, a prototype test was made wherein U-Mo canned slugs containing NaK reservoirs were hack sawed underwater. The studies demonstrated that the NaK reservoirs can be safely deactivated by hack sawing under a submerged hood in a shallow water bath. (W.L.H.)

11053 (NAA-SR-5688(p.69-87)) STATUS OF PROCESS DEVELOPMENT FOR ORGANIC REACTORS. W. R. Martini (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The coolant for an organic reactor must be purified continuously to remove the radiolysis and contamination products as they are found and dispose of these products in a safe and economic manner. Processes to do this have been perfected for an 11.4-Mw(e) organic reactor (Piqua). Experimental equipment consisting of an impurity removal loop and Piqua prototypes is described. Existing knowledge is summarized on impurity removal, purification, degasification, disposal of high boilers, waste-gas disposal, and water disposal. (T.R.H.)

11054 (NP-9733) THE URANIUM(VI)–NITRATE–TRIBUTYL PHOSPHATE SOLVENT EXTRACTION SYSTEM. A THERMODYNAMIC ANALYSIS. Y. Marcus (Israel. Atomic Energy Commission, Tel-Aviv). Oct. 1960. 41p. (IA/582)

A thermodynamic analysis of a solvent extraction system ($UO_2(NO_3)_2$-TBP) is presented. Theoretical equations are derived, or appropriately modified, and compared with published experimental data. Some of the effects taken into account are: extraction of nitric acid, incomplete dissociation of this acid, hydration of the TBP, and aqueous complexing and hydrolysis of the uranyl ion. The treatment may be applied also to other systems of coextraction, such as plutonium with uranium nitrate into TBP. (auth)

11055 (ORNL-3051) PLUTONIUM EXTRACTION FROM NITRATE AND SULFATE SOLUTIONS BY AMINES AND ORGANOPHOSPHORUS COMPOUNDS. D. E. Horner and C. F. Coleman (Oak Ridge National Lab., Tenn.). Mar. 9, 1961. Contract W-7405-eng-26. 64p.

Plutonium extraction coefficients from acid nitrate and sulfate solutions by amines and some neutral and acid organophosphorus compounds were measured as functions of several extraction variables, including plutonium valence, acid and salt concentration, and extractant concentration. Extractability by all the reagents varied in the order Pu(IV) > Pu(VI) > Pu(III); however, several systems showed usefully high extractions of plutonium from stabilized Pu(III) solutions. Primary amines extracted Pu(IV) sulfate much more strongly than the nitrate; most of the other reagents extracted the sulfate much less strongly than the nitrate, but still to a usable extent in some systems. Plutonium(IV) nitrate extractions with the different extractants passed through maxima at widely different nitric acid concentrations. With most, but not all, extraction increased when nitric acid was replaced with nitrate salt. (auth)

11056 (ORNL-3064) RECOVERY OF URANIUM FROM AMINE EXTRACTANTS WITH AMMONIUM CARBONATE. F. J. Hurst and D. J. Crouse (Oak Ridge National Lab., Tenn.). Mar. 1, 1961. Contract W-7405-eng-26. 22p.

An economical process was developed through bench-scale experiments for recovering uranium from amine extractants with ammonium carbonate solution. By recycling the strip solution to allow build-up in the concentration of ammonium sulfate (formed in the stripping reactions) to 1–2M, the solubility of uranium in the aqueous phase was limited to <5 g/liter and ammonium uranyl tricarbonate (AUT) precipitated in the stripping system. The AUT, which settled and filtered rapidly, was readily converted to U_3O_8 by calcination at 500°C, yielding a high assay (>97% U_3O_8) concentrate virtually free of sodium, molybdenum, and vanadium. Estimated reagent costs for the stripping-precipitation step were 7¢ per pound of U_3O_8. (auth)

11057 (TID-11747) MASS (BATCH) CONTROL AND ITS APPLICATIONS. A. J. Mallett (Oak Ridge Gaseous Diffusion Plant, Tenn.). 1960. 23p.

To be presented at a Symposium on Criticality Control in Chemical and Metallurgical Plant, Karlsruhe, Germany, May 2-5, 1961.

Problems of nuclear safety control associated with various operations in which the quantity of uranium materials handled is specifically referred to as safe-batch or safe-mass are discussed. Factors involved in determining safe conditions for batch operation include enrichment, moderation, density, reflection, and neutron poisons. The safety factor by which critical mass values are reduced for safe-mass operation depends on the adequacy of the control of the processing operations. Some of the problems involved in sampling and analyzing batch processes are described. The problems of interaction or neutron exchange and spacing requirements when one or more containers are involved are discussed. Conditions for using nuclear poisons are outlined. It was concluded that frequent checks of every phase of the operation is the key to safe operation. (M.C.G.)

11058 (AEC-tr-4411) USE OF RADIOACTIVE ISOTOPES FOR THE STUDY OF FLOTATION PROCESSES. I. N. Plaksin, S. N. Zaĭtseva, G. N. Khazhinskaya, and R. Sh. Shafeev. Translated from Report No. RICC/308 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 25p.

Investigations of the flotation process of enriching metals conducted by classical methods of analytical chemistry are, in general, inapplicable in studies of the interaction of flotation reagents with minerals. The basic problem in this case is a study of the layers formed on the surface of the mineral particles within the limits of thickness comparable to the monomolecular layer. Radiometric and microautoradiographic methods are described for use in these studies. Radioisotopes were used in studies of certain causes of the difficult floatability of pyrrhotite and zinc blende, studies of the characteristics of fixation of xanthogenate on the surface of sulfide minerals, studies of the characteristics of fixation of kerosene on molybdenite, studies of the joint action of xanthogenates of various alcohols, and studies of the interaction of a cation collector with hubnerite and wolframite. (C.H.)

11059 (CEA-tr-R-1056) PROBLEME DE LA SOLUBILITE DU NITRATE D'URANYLE DANS LES SOLVANTS ORGANIQUES. (Problem of Solubility of Uranyl Nitrate in Weak Organic Solvents). V. M. Vdovenko, I. G. Suglobova (Souglobova), and D. N. Suglobov (Souglobov). Translated into French by A. Khazov from Radiokhimiya, 1: 637-44 (1959). 21p.

The mutual solubility in the three-component system uranyl nitrate–water–ether was studied. The ethers used were diethyl and β,β′-dichlorodiethyl. The solubilities were measured at 25° with low water concentrations. A description is given of the solubility of uranyl nitrate and its hydrates in various organic solvents. The effect of the proper-

ties of the molecules of the solvent and of the character of the uranyl nitrate solvation on the solubility was examined. (J.S.R.)

11060 (CEA-tr-1110) CONCENTRATION DU CESIUM RADIOACTIF A L'AIDE DE FORMATION DE MOUSSE DE GELATINE. (Concentration of Radioactive Cesium by Formation of Hydrosols and Gelatins.) V. V. Pushkarev, L. D. Skrylev, and V. F. Bagretsov. Translated into French from Radiokhimiya 1: 709-11(1959). 8p.

A study was made of the concentration of Cs^{134} solutions by adsorption on chemical compounds followed by extraction using formation of a foam of the solid phase. The Cs^{134} was adsorbed on ferro- and ferricyanide precipitate, part of which remains in colloidal form. A 1% gelatin solution was added, followed by agitation. The solution is then placed in a glass column into which air is blown to form a foam. The foam retains the precipitate and colloid and only 0.5 to 4.0% of the solution. The technique is more thorough and faster than filtration and centrifugation methods. (T.R.H.)

11061 (CEA-tr-R-1123) EXTRACTION DU NEPTUNIUM PENTAVALENT. (Extraction of Pentavalent Neptunium). I. P. Alimarin, Yu. A. Zolotov, and E. S. Palshin. Translated into French from Doklady Akad. Nauk S.S.S.R., 124: 328-30(1959). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 9851.

11062 (UCRL-Trans-613(L)) FOCUSSING ION EXCHANGE I. PRINCIPLE AND SIMPLE THEORY. Ernst Schumacher. Translated from Helv. Chim. Acta, 40: 221-8 (1957).

This paper was previously abstracted from a French translation and appears in NSA, Vol. 13, abstract No. 21994.

11063 SEPARATION OF URANIUM FROM FISSION PRODUCTS USING CELLULOSE. Noboru Oi (Tokyo Shibaura Electric Co., Ltd.). Bull. Chem. Soc. Japan, 33: 1617-18(Nov. 1960). (In English)

Uranium can be separated from fission products by passing an organic solution of uranyl nitrate through a column of cellulose pulp, which retains nearly all the fission products. After uranium is washed from the column with organic solvent, 0.2M HNO_3 can be used to elute the fission products. The effects of various conditions, e.g., water, nitric acid in organic solvent, and uranium content, on fission-product elution are discussed. Of the fission-product nuclides, iodine, ruthenium, and cesium were found to contaminate the organic solvent, ruthenium being the most troublesome. The amounts of gamma activity eluted by ether, three acetates, and a ketone are tabulated. (D.L.C.)

11064 THE REFINING OF METALLIC LITHIUM. T. F. Fedorov and F. I. Shamrai. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 56-60(Nov.-Dec. 1960). (In Russian)

Metallic lithium prepared by either electrolytic or metallothermic process usually contains about 1% impurities. An attempt was made to purify the metal by different methods. Chemical methods were found to be laborious and required relatively pure starting materials. If the pressure is not greatly reduced, ordinary distillation does not appear to be much better; as the structure of the liquid metal systems are not too well known the optimum conditions cannot be easily calculated. Fractionate distillation at a residual pressure of 5 to $6 \cdot 10^{-4}$ mm Hg at 300 to 400°C yielded a product with a sodium and potassium content of less than 0.01%; however, this method did not eliminate the magnesium impurity. Very good results were obtained by repeated operation in a refining column: a starting material containing 98.6% lithium yielded a product with a purity of more than 99.99%. The low-boiling components such as potassium, sodium, and magnesium were held at the dephlegmator, while the nonmetallic impurities remained in the residue. (TTT)

11065 INORGANIC EXTRACTION STUDIES ON THE SYSTEM BETWEEN TRI-N-BUTYL PHOSPHINE OXIDE AND HYDROCHLORIC ACID. Tomitaro Ishimori, Kenju Watanabe, and Takeo Fujino (Japan Atomic Energy Research Inst., Tokyo). J. At. Energy Soc. Japan, 3: 19-25 (1961). (In English)

A radiochemical survey on the extraction behavior of about sixty chemical elements was performed in 1% TBPO toluene solution and hydrochloric acid system. The distribution ratios between organic and aqueous phases were obtained for 1, 2, 4, 6, 8, 10, and 12M of hydrochloric acid, respectively. Although the chemical form or the oxidation state could not be defined unambiguously in several cases, familiar chemical forms were chosen as far as possible. Radioactive tracers were employed for determining distribution ratios, which were obtained by measuring the radioactivities of both phases, respectively. The distribution ratios were very similiar for each family of elements. From relationships between distribution ratios and acid concentration in this system, suitable concentrations can be found for separating a pair of ions chosen arbitrarily. In comparing the acid dependence curves in this system with those in 100% TBP–HCl system, remarkable similarities were observed, however, those in 1% TBPO–HCl system showed generally lower values than in 100% TBP–HCl system. (auth)

11066 THE SOLVENT-EXTRACTION OF BERYLLIUM FROM AQUEOUS SOLUTIONS OF MINERAL ACIDS BY ALKYL ESTERS OF PHOSPHORIC ACID. C. J. Hardy, B. F. Greenfield, and D. Scargill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 174-82(Jan. 1961).

The solvent extraction of beryllium from aqueous mineral acid solutions by a variety of monoalkyl and dialkyl esters of phosphoric acid was studied by using the radioactive isotope Be^7. The distribution coefficient (D_{Be}) was measured as a function of the equilibration time, the nature and concentration of the aqueous acid, the purity, concentration, and structure of the ester, and the nature of the diluent in the organic phase. The time required to reach equilibrium depends on the purity and structure of the ester and the concentration of aqueous acid, varying from 15 min for di-n-butyl to ~1000 min for di-2-ethylhexyl hydrogen phosphate. Beryllium is extracted from dilute (<2M) aqueous acid solution by the dialkyl esters predominantly as the complex $BeA_2(HA)_2$ [$A = (RO)_2PO \cdot O^-$], but, at higher aqueous acid concentration, complexes containing the anion of the aqueous acid are probably also extracted. The structure of the alkyl group has a slight effect on the value of D_{Be}, this value decreasing as the degree of branching increases and increasing with chain length. The value of D_{Be} varies considerably with the nature of the diluent and increases in the order chloroform < toluene < benzene < carbon tetrachloride < kerosene. Equilibrium constants for the complexes $BeA_2(HA)_2$ have been calculated for a series of alkyl groups with toluene as diluent. Formation constants for the $BeCl^+$, BeF^+, BeF_2, and BeF_3^- complexes in the aqueous phase were also calculated from results on the variation of D_{Be} with the concentration of chloride ion and fluoride ion. (auth)

11067 NEPTUNIUM COMPLEX ION SPECIES EXTRACTED FROM NITRIC ACID–PERCHLORIC ACID MIXTURES BY TRIBUTYL PHOSPHATE. W. E. Keder

(General Electric Co., Richland, Wash.). J. Inorg. & Nuclear Chem., 16: 138–41(Nov. 1960). (In English) (HW-SA-1745)

Neptunium(IV) and neptunium(VI) were extracted into TBP-xylene from nitric acid–perchloric acid mixtures, and the absorption spectra of the neptunium were measured in both phases. The spectra of the neptunium in the TBP solutions were found to vary with the aqueous-phase composition. It was concluded that more than one complex-ion species extracts in each case and that three neptunium(VI) species are indicated. (auth)

11068 THE EXTRACTION OF URANYL NITRATE BY PHOSPHATE IN THE PRESENCE OF SOME NITRATE SALTING-OUT AGENTS. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. & Nuclear Chem., 16: 156–8(Nov. 1960). (In English)

The salting-out effect of some nitrates on the extraction of uranyl nitrate by TBP was investigated. The percentage of uranyl nitrate extracted was determined at various nitric acid concentrations in the presence of NH_4NO_3, $LiNO_3$, $NaNO_3$, KNO_3, $Cu(NO_3)_2$, $Mg(NO_3)_2$, $Ca(NO_3)_2$, $Zn(NO_3)_2$, $Al(NO_3)_3$, and $Fe(NO_3)_3$. It was found that the presence of nitrate salting-out agents favors the extraction of uranyl nitrate and that the effects are most remarkable at low acidities. (M.C.G.)

11069 THE PRIMARY SOLVATION OF THE PROTON IN THE SOLVENT EXTRACTION OF STRONG ACIDS. D. G. Tuck (Univ. of Nottingham, Eng.) and Richard M. Diamond. J. Phys. Chem., 65: 193–8(Feb. 1961).

Evidence is reported for the presence of the trihydrated hydronium ion, $H_3O(H_2O)_3^+$, in extracts from aqueous solutions into basic organic solvents of the strong acids $HClO_4$, HBr, and HCl. In the organic phase, this species is further solvated by (hydrogen-bonded) coördination to the basic organic molecules, and so the degree of extraction depends partly upon the coördinating ability of the solvent molecules. With the somewhat weaker acids, HNO_3 and CCl_3CO_2H, the proton coordinates preferentially in the low-dielectric-constant organic phase with the more basic (charged) anion than with water. The molecule formed is solvated by water and (or) organic solvent molecules, depending upon the solvent basicity. For solvents such as the ethers and ketones, the resulting species is $HNO_3 \cdot H_2O$(sol), and with the more basic tributyl phosphate, an anhydrous species, $HNO_3 \cdot$ TBP(sol), results. (auth)

11070 GAS-LIQUID CHROMATOGRAPHY IN CAPILLARY COLUMNS. PART I. THEORY. P. C. Haarhoff and Victor Pretorius (Univ. of Pretoria). J. South African Chem. Inst., 13: 97–115(Oct. 1960). (In English)

A rigorous general treatment of linear nonideal gas-liquid chromatography in capillary columns is presented. All the column parameters other than the column dimensions and the thickness of the retentive liquid layer are treated as continuous time-dependent functions of the distance from the column inlet. The results are shown to be valid provided only that the column contains a large number of theoretical plates. (auth)

11071 GAS-LIQUID CHROMATOGRAPHY IN CAPILLARY COLUMNS. PART 2. FACTORS AFFECTING THE COLUMN EFFICIENCY: THE DISTRIBUTION COEFFICIENT, THE DIFFUSIVITY OF THE SOLUTE IN THE GASEOUS AND LIQUID PHASES, AND THE THICKNESS OF THE LIQUID LAYER. P. C. Haarhoff and Victor Pretorius (Univ. of Pretoria). J. South African Chem. Inst., 13: 116–24(Oct. 1960). (In English)

The effect of the distribution coefficient, the diffusivity of the solute in the gaseous and liquid phases, and the thickness of the liquid layer on the efficiency of a capillary column was theoretically examined, using the height equivalent per theoretical plate, based on apparent retention as a measure of the efficiency. Graphical results are given which may be used to estimate the column efficiency when the values of the parameters are known. The existence of an optimum value of the thickness of the liquid layer is demonstrated. It appears that very high column efficiencies are possible when both the distribution coefficient and the ratio of the diffusivity of the solute in the gaseous phase to that in the liquid phase are relatively small. (auth)

11072 CARRIER-FREE SEPARATION OF RHODIUM-102 FROM RUTHENIUM TARGET. Hikaru Shimojima (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 561–4 (Apr. 1960). (In Japanese)

The carrier- and salt-free separation of Rh^{102} from the ruthenium target was investigated. Rh^{102} was produced by bombarding the ruthenium metal with 12.5-Mev protons using the 63-in. cyclotron at the Institute for Nuclear Study, University of Tokyo. After addition of iron as the collector for rhodium, the bombarded target was fused with KOH and KNO_3. Ruthenium comes to the aqueous solution, and rhodium remains in the residue. The residue was fused with $KHSO_4$ to make rhodium completely soluble in an aqueous solution. Foreign ions were separated with the ion exchange resin column. A great difference in the chemical behavior of rhodium was found in the presence or absence of the stable rhodium carrier. Applying this separation method, sources for the β spectrometry and for the measurement of γ–γ angular correlation were prepared. The separation is made rapidly and completely, and is useful for the study of the short-lived isotopes of rhodium. (auth)

11073 SEPARATION OF RADIOACTIVE ELEMENTS USING ION EXCHANGE MEMBRANE. I. CONCENTRATION OF CARRIER-FREE ^{90}Y FROM ^{90}Sr–^{90}Y SOLUTION. Hidehiro Goto, Shin Suzuki, and Makato Saito (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 81: 578–82(Apr. 1960). (In Japanese)

Recently an ion exchange membrane was used for the treatment of radioactive wastes, but it is rarely used. The authors used an ion exchange membrane for concentration of carrier-free Y^{90} from the Sr^{90}-Y^{90} solution. Sr^{89} was used for the preliminary experiments. The study was carried out with the electrolysis method. Several electrolysis tubes of S.B. glass, 20 mm in diameter and 40 mm in length were connected. The ion exchange membrane (Amberplex C-1, A-1) was packed between the electrolysis tubes. The electrodes used were platinum plates of 1.0 cm^2. The 12.0-volt battery was used as source of the electric power. The following results were found: Y^{90} passed through the anion exchange membrane in the weakly acidic solution; the amount of the radioactive nuclide passing through the ion exchange membrane was affected by the electrolytic current and it was proportional to the concentration of electrolytes; the purity of the carrier-free Y^{90} separated from the 1.0×10^{-3} M NH_4Cl solution of pH 3.0 was 99.9%. The increase of the foreign ion concentration gave the bad result for the separation with the ion exchange membrane because of the increasing electrolytic current. (auth)

11074 RECOVERY OF Ag^{110m} FROM ITS WASTE SOLUTION BY COPRECIPITATION WITH CUPRIC SULFIDES. Kiyoshi Kudo (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 81: 1174(July 1960). (In Japanese)

From radioactive waste solutions of $\sim 10^{-3}$ μc/ml of Ag^{110m}, most of the silver (~97%) was coprecipitated with copper as sulfides, residual activity being $\sim 10^{-3}$ μc/ml. H_2S was passed through 10 ml of a radioactive waste solution which contained a suitable amount of Cu^{2+} and was acidified to about 0.3N in HCl. After being heated the solution was kept standing for 30 min and then filtered. The filtrate was evaporated to dryness and its radioactivity was determined by a Lauritsen electroscope. By repeated procedures, the recovery yield was increased up to 99%. (auth)

11075 REACTION OF ZIRCONIUM WITH ION-EXCHANGERS. Yosihiro Mori, Hidetake Kakihana, and Shin Hata (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 81: 1263-6(Aug. 1960). (In Japanese)

A study was made of the effect of temperature and cross-linking on the reaction of zirconium with cation exchangers. The exchangers of zirconium-form were prepared by passing 1N nitric acid solution containing 10 g of $ZrOSO_4$ per liter through columns of H-form exchangers. From the quantity of zirconium in the exchangers, the apparent ionic charge of a zirconium atom was estimated as 3.3 to 0.39 on Dowex 50-X1, 2.5 to 1.24 on -X8 and 4.1 to 1.51 on -X16. Distribution coefficients K_d of zirconium on the exchangers with HCl, HNO_3, H_2SO_4, citric acid–HNO_3, tartaric acid–HNO_3, and oxalic acid–HNO_3 were determined at 30, 50, and 80°C. The distribution coefficient K_d is influenced by the change of temperature and the kind of the solution, slightly on Dowex 50-X1, but notably on Dowex 50-X8 and -X16. Dowex 50-X8 has the smallest value of K_d among these exchangers. (auth)

11076 EXTRACTION AND SEPARATION OF THORIUM FROM RARE EARTHS BY AZINES. Kakuzo Tada, Noboru Oi, and Yasuko Tsuge (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Nippon Kagaku Zasshi, 81: 1554-8(Oct. 1960). (In Japanese)

Thorium was extracted and separated very excellently from rare earths in aqueous solution containing ammonium nitrate by using a mixture of methyl isopropyl ketone and azine (methylisobutylketazine, isophoroneketazine, or dibenzalhydrazine) as a mixed solvent. These solvents were found to be able to extract thorium more effectively than methyl isobutyl ketone alone or TBP. The extractability of rare earths in the presence of thorium (0 ~ 0.5M) was checked by the use of radioscope Ce^{144}, Pr^{144}, Sm^{153}, $Eu^{152\sim4}$, and Tm^{170}. Although the addition of azines caused the increase of rare-earth extraction, its degree was considerably small compared with the enhancement of thorium extraction, and an accordingly large separation factor was obtained (100 ~ 1000 fold larger than TBP or mesityl oxide at the thorium concentration below 0.3M). It seems evident that ketone-azine mixture is effective, especially in one-batch contact extraction for the analytical separation of thorium from rare earths. (auth)

11077 THE INFLUENCE OF TETRABUTYLAMMONIUM NITRATE ON EXTRACTION OF CERIUM(IV) INTO NITROMETHANE. Eugeniusz Wężranowski (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 677-80(1960). (In English).

The percentage of Ce(IV) (labeled by Ce^{144}) extracted to nitromethane from different HNO_3 concentrations was established. The influence of tetrabutylammonium nitrate (TBAN) on the extraction was examined. The formula for a compound of Ce(IV) with TBAN as $(Bu_4N)_2Ce(NO_3)_6$ was found. This compound is probably dissociated in the organic phase. (auth)

11078 EXTRACTION OF PENTAVALENT NEPTUNIUM BY 1-NITROSO-2 NAPHTHOLATE. I. P. Alimarin, Yu. A. Zolotov, and E. S. Pal'shin. Radiokhimiya, 2: 637-42(1960). (In Russian)

Pentavalent neptunium is extracted at pH = 9 to 10 by 1-nitroso–2-naphthol in n-butyl and isoamyl alcohol solutions. Optimum separation conditions are found. The extraction of 1-nitroso–2-naphthol neptunium (V) can be applied for separating indicator quantities of Np^{239} from admixture salts and microquantities of Np^{237} from plutonium and uranium. (R.V.J.)

11079 THE PRINCIPLE OF SELECTIVE URANYL NITRATE EXTRACTION BY TRI-N-BUTYLPHOSPHATE. S. Mints and S. Libus. Radiokhimiya, 2: 643-52(1960). (In Russian)

The high selectivity of uranyl nitrate extraction by tri-n-butyl phosphate is ascribed to the uranyl ions strong ability for coordinating nitrate ions through its two oxygen atoms and also to strong uranyl ion complexing by tri-n-butyl phosphate, the value of which is 6 in butyl alcohol medium. The corresponding constant for nickel nitrate is 0.8. (R.V.J.)

11080 SALTING OUT ACTION OF NITRATES. N. M. Adamskiĭ. Radiokhimiya, 2: 653-8(1960). (In Russian)

The relation between the amount of hydration water, molar volume of salts, ionic force in solutions, and extraction was determined. On the basis of equilibrium aqueous solutions, the developed equations predict the uranyl distribution in the presence of a salting out agent. The obtained and published data are in good agreement. (R.V.J.)

11081 ON SEPARATION OF TETRAVALENT URANIUM OXALATE BY RONGALITE. A. A. Grinberg, D. N. Bykhovskiĭ, L. E. Nikol'skaya, and G. I. Petrzhak. Radiokhimiya, 2: 687-90(1960). (In Russian)

The losses of uranium in filters were determined by means of U^{233}, and the conditions for separating small quantities of uranium (up to 0.2 g/liter) on rongalite were found. It is shown that in separation of small concentrations of uranium, rongalite concentration should be not less than 0.1M. (R.V.J.)

11082 ADSORPTION–ELECTROCHEMICAL METHOD OF SEPARATION OF RADIOACTIVE ZIRCONIUM AND NIOBIUM. N. A. Balashova and N. S. Merkulova. Radiokhimiya, 2: 699-703(1960). (In Russian)

Separation of radioactive zirconium and niobium from dilute nitric acid and fluorine solutions was achieved by the adsorption-electrochemical method. The electrolysis with platinum and steel electrodes produced pure niobium on the cathode and pure zirconium in the solution. (R.V.J.)

11083 ADSORPTION–ELECTROCHEMICAL SEPARATION OF RADIOACTIVE CERIUM AND PRASEODYMIUM. N. A. Balashova and N. S. Merkulova. Radiokhimiya, 2: 704-10(1960). (In Russian)

A method is suggested for separating microquantities of cerium and praseodymium from their mixtures in bi-nitrate solutions or on metallic surfaces. Experiments showed that cerium passes from the solution to the platinum or stainless steel electrodes at potentials above 1.5v (against ordinary hydrogen electrode) while praseodymium remains in the solution. Under similar conditions with the mixture of cerium with praseodymium placed on the surface of a metal, praseodymium passes into the acid solution, while cerium remains on the metal surface. The mechanism of separation is based on the difference between the adsorption ability of the elements during cerium transition into higher valence state at high anode potentials. (R.V.J.)

11084 METHODS OF CONTINUOUS ELECTROPHORESIS IN SEPARATION OF RARE-EARTH GROUP FRAG-

MENTS FROM U^{233} PHOTOFISSION. V. P. Shvedov, K. A. Petrzhak, R. V. Sedletskiĭ, and A. V. Stepanov. Radiokhimiya, 2: 711-14(1960). (In Russian)

Radiochemical carrier-free separation of rare-earth fragments from the U^{238} photofission products is described. The method of continuous electrophoresis is applied in separation of short-life rare-earth fragments. (R.V.J.)

11085 SEPARATION OF RADIOACTIVE ISOTOPES ON MERCURY CATHODE. IV. SEPARATION OF Pm^{147}. V. P. Shvedov and I-pei Fu. Radiokhimiya, 2: 715-19(1960). (In Russian)

Optimum conditions are found for Pm^{147} separation with various addends and with additions of lithium carbonate in the electrolyte. The best results were obtained with lactic acid. Somewhat smaller yields were obtained with citric and succinic acid. Separation of 99% Pm^{147} was achieved with lactic acid. (R.V.J.)

11086 SEPARATION OF RADIOACTIVE ISOTOPES ON MERCURY CATHODE. V. SEPARATION OF Nb^{95} WITH A CARRIER. V. P. Shvedov and I-pei Fu. Radiokhimiya, 2: 720-2(1960). (In Russian)

An attempt is made at separating niobium from oxalate-acetate solution on a mercury cathode. The effects of various factors affecting the separation of niobium in this medium are studied, and optimum conditions are found. A yield of 98.3% niobium is obtained in 30 min. (R.V.J.)

11087 SEPARATION OF $La^{140}-Y^{91}$, $La^{140}-Pm^{147}$, AND $Sr^{90}-Y^{90}$ WITH THE TRIVALENT CERIUM IODATE PRECIPITATE. V. P. Shvedov and S. A. Musaev. Radiokhimiya, 2: 723-7(1960). (In Russian)

Experiments uncovered complete La^{140}, Pm^{147}, Y^{90}, and Sr^{90} bonding by trivalent cerium precipitation in saturated KIO_3 solution. It is postulated that ions and KIO_3 do not form soluble ion complexes. Slow decomposition of complex cerium and presence of KIO_3 create conditions inducing homogeneous Ce^{3+} iodate precipitation and separation of the mixtures of $La^{140}-Y^{91}$ and $Sr^{90}-Y^{90}$ on the precipitant. (R.V.J.)

11088 ION-EXCHANGE OF ALKALI ELEMENTS. O. M. Lilova and B. K. Preobrazhenskiĭ. Radiokhimiya, 2: 728-30(1960). (In Russian)

A successful separation of alkali elements by phenol-formaldehyde sulfocationite KU-1 is analyzed. Complex formation of elements with phenol resin group rapidly increases in transition toward heavier elements and results in good separation ($\alpha_{Cs/Rb} = 4.2$). This effect is especially pronounced with francium. (R.V.J.)

11089 ION EXCHANGE SEPARATION OF ELEMENTS. VI. ALKALI EARTH ELEMENTS. O. M. Lilova and V. K. Preobrazhenskiĭ. Radiokhimiya, 2: 731-3(1960). (In Russian)

Alkali earth element separation (Mg, Ca, Sr, Ba, and Ra) by ion exchange on sulfostyrene cationite (KU-2 or Dowex-50) at 20 to 90° and using ammonium acetate reagent was achieved. The coefficient of separation did not exhibit any dependence on the effects of the resin structure hardness (the content of divinylbenzole). Comparisons of various elution agents indicate ammonium acetate as more effective at room temperature while ammonium lactate gives better results at elevated temperature (80°). Applications of weak complexing agents in large concentration permitted an increase of the column without infringing on the normal separation. (R.V.J.)

11090 EFFECTS OF MINERAL CRUSHING ON THE LEACHING OF RADIOACTIVE ELEMENTS. I. E. Starik and K. F. Lazarev. Radiokhimiya, 2: 749-52(1960). (In Russian)

The relation between leaching and the degree of monazite crushing was studied with ThX, U, RdTh, and Th. The results showed that variations in leaching of minerals depend on the changes in the mineral surface and the adsorption properties of the surface. (R.V.J.)

11091 EXTRACTION OF URANIUM(VI) FROM NITRIC ACID SOLUTIONS BY TRI-N-OCTYLAMINE. V. B. Shevchenko, V. S. Shmidt, and E. A. Nenarokomov. Zhur. Neorg. Khim., 5: 2354-62(Oct. 1960). (In Russian)

The regularities in U(VI) extraction by tri-n-octylammonium nitrate in xylene and carbon tetrachloride of uranium organic phase concentrations up to 0.1 mole/liter are described by $UO_2^{2+}(aq) + 2NO_3^-(aq) + TOA \cdot HNO_3(org) \rightleftharpoons (TOA \cdot H)UO_2(NO_3)_3(org)$, where $(TOA \cdot H)UO_2(NO_3)_3$ is completely transferred into the organic phase. (R.V.J.)

11092 PROCESS FOR CONCENTRATING PLUTONIUM AND/OR URANIUM. (to U. S. Atomic Energy Commission). British Patent 855,490. Nov. 30, 1960.

A method is given for concentrating plutonium and/or uranium in an aluminum alloy. The method is comprised by adding $ZnCl_2$ or AlF_3 (which forms a subfluoride) to the aluminum alloy and heating the mixture to volatilize the aluminum halide formed along with unreacted halide. A large part of fission products that are present in the alloy is removed in this method, either by volatilization or oxidation to form a scum on the alloy surface; only ~5% of the γ activity is retained. Two examples of the method are given in which the plutonium concentration in an aluminum–plutonium alloy is increased from 10 to 12.5 and 17 wt.%, respectively. (D.L.C.)

11093 LIQUID-LIQUID CONTACT EXTRACTOR. (to Atomic Energy of Canada Ltd.). British Patent 860,428. Feb. 8, 1961.

A liquid-liquid contact extractor of the multistage mixer-settler continuous countercurrent type is designed for immiscible liquids of different specific gravities. The extractor consists of a plurality of mixer-settler units arranged in horizontal stages, the mixing and moving of the liquid phases being done with a flow of a gas. The advantages of this extractor are that no vertical shielding is needed in case of radioactive liquids, as in extraction of solutions of irradiated uranium or plutonium, and maintenance of moving parts is avoided. (D.L.C.)

11094 CONCENTRATION OF PLUTONIUM. David Moore Ritter and Robert Phillip Spence Black. British Patent 860,458. Feb. 8, 1961.

A method is given for the concentration of plutonium in irradiated uranium and other plutonium-containing materials. In this method, the material is dissolved in acid and subjected to bismuth phosphate precipitation, the precipitate is dissolved and re-precipitated as an oxalate. The oxalate carrier, but not plutonium, is oxidized, and the precipitate is finally treated by lanthanum fluoride precipitation. (D.L.C.)

11095 SEPARATION OF PLUTONIUM. (to United Kingdom Atomic Energy Authority). British Patent 860,459. Feb. 8, 1961.

A method is given for the preparation of granular zirconium pyrophosphate for use as an adsorbent in separating plutonium from irradiated uranium. In this method, zirconium orthophosphate is precipitated from solution and converted into pyrophosphate by dehydration. The applications of this adsorbent material to plutonium separation are illustrated by many examples using irradiated uranium in which the effects of various factors (e.g., uranyl ions) on absorption and elution of plutonium are studied. (D.L.C.)

11096 IMPROVEMENTS IN OR RELATING TO THE SEPARATION OF GASEOUS AND VAPOROUS MEDIA. Rudolf Ernst Peierls, Franz Eugen Simon, and Henry Shull Arms (to United Kingdom Atomic Energy Authority). British Patent 860,752. Feb. 8, 1961.

A method is given for separating gaseous or vaporous media by diffusion through a permeable membrane. In this method, two sheets of the mixture separated by the membrane are subjected to pressure variations, which produce an alternating pressure difference acting on the membrane in opposite directions, and to a periodic motion parallel to the membrane and of the same frequency as the alternating pressure difference. A unidirectional concentration gradient is set up parallel to the periodic motion, and fractions can be taken off at or near the concentration extremes. In this manner, it is possible to obtain a multiplicity of separation stages without physical separation of the stages. (D.L.C.)

11097 TREATMENT OF NEUTRON-IRRADIATED THORIUM. (to United Kingdom Atomic Energy Authority). British Patent 860,753. Feb. 8, 1961.

Methods are given for irradiating thorium to produce U^{233} and for chemically treating irradiated thorium to separate U^{233} and Pa^{233}. After irradiation, thorium is dissolved in acid and (1) treated to precipitate the peroxides of thorium and uranium, (2) treated with Hf to precipitate thorium, or (3) treated to precipitate MnO_2, which carries down Pa^{233}. Auxiliary processes for purifying the separated elements are also given. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

11098 (AD-242213) BIBLIOGRAPHICAL STUDY ON DUST CONTROL ENGINEERING—METHODS, EQUIPMENT AND APPLICATIONS. G. I. Chandler (Autonetics Div., North American Aviation, Inc., Downey, Calif.). Mar. 31, 1960. 126p. (EM-5980)

References (340) to books, reports, papers, and periodical articles are included on particle motion studies and the brownian movement; principles and methods of particle analysis and size determination; theory and comparison of equipment and instruments for dust analysis; special techniques, including electron microscopy; filters and filtration; and dust control in industry. References are arranged by author under the year of publication. Material dates from 1827, with emphasis on information published between 1950 and 1959. The report is partially annotated; abstracts are included where possible. An author index and a subject index (in outline form) follow the abstracts. (auth)

11099 (AERE-R-3051) A SMALL ROTARY SAMPLER AND PRELIMINARY STUDY OF ITS USE. R. W. M. Hawes and L. D. Muller (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 22p.

A small rotary sampler for use with dry granular materials is described. Designed specifically for the sampling of ore products for quantitative mineralogy, it has applications in other fields. The principle of the sampler's design and operation is outlined and is compared critically with the microriffle. The problem of investigating sampler behavior is discussed, and an expression for the efficiency of samplers and sampling devices is proposed. The difficulties of designing unambiguous tests are indicated. Preliminary investigations employing statistical treatment are described. Some confirmation of the superiority of the sampler over the microriffle was obtained. (auth)

11100 (CF-59-11-123) SOME MISCELLANEOUS MAINTENANCE TOOLS USED TO MANIPULATE LOOSE OBJECTS IN THE HRT CORE. P. P. Holz (Oak Ridge National Lab., Tenn.). Nov. 17, 1959. 17p.

A description of several miscellaneous HRT core maintenance tools is given. Function, design, and operation are described for several items including screen pickup and transfer tools, screen alignment tools, screen hanger tools, a pawl clamp, hooks, a bellows flange hanger, grapples and clamp hooks, grip-and-flex tools, and screen edge sample cutter. (auth)

11101 (DLCS-1450102) CRANES AND HOISTS. CORE 1, SEED 1. Test Results T-550124. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 7, 1960. 8p.

Tests were made to prove the integrity of cranes and hoists prior to their use in lifting major components. (W.L.H.)

11102 (DP-506) CONTINUOUS SOLVENT WASHING-HYDRAULIC CHARACTERISTICS OF THE TURBINE CONTACTOR. Donald S. Webster and Clifton L. Williamson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1960. Contract AT(07-2)-1. 20p.

The pumping characteristics of a turbine contactor were measured with several different paddles inside a shrouded diffuser. The maximum pressure was developed at no flow and was about 0.6 of the velocity head of liquid moving at the velocity of the paddle tip. The maximum flow occurred at no pressure development and was about 0.2 of the flow calculated by the product of the velocity of the paddle tip and the peripheral area of the paddle. Between these extremes, the head decreased from the maximum by an amount proportional to the second power of the flow. (auth)

11103 (DP-538) LEAKAGE OF WATER FROM VALVE STUFFING BOXES. Frederick C. Apple (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1961. Contract AT(07-2)-1. 12p.

The leakage of water from the stuffing boxes of four commercially available valves was measured under simulated power reactor conditions. Average leakage rates between 0.1 and 10 lb per year were measured for three fully open valves of $\frac{3}{4}$- to 6-in. size during a test in which they were pressure and thermal cycled 100 times to 1000 psig and 240°C. The average leakage during a test in which a 3-in. valve was opened and closed 1100 times at 260°C and 850 to 1000 psig was 30 lb per year. (auth)

11104 (HW-63358) PUMP AND AGITATOR DEVELOPMENT 1959. Summary Report. J. Dunn (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 13, 1960. 12p.

A submersible, 4-in. diameter, 21-stage, bronze water well pump was evaluated for cold usage at HAPO. The pump was operated with water as test fluid until failure at 5005 hr. Fluid pressure deformation of the impellers was noted in each stage. No further testing is contemplated, and the pump is not recommended. Tests of a stainless-steel-canned titanium pump are reported, however these were stopped because the bearing design was not satisfactorily worked out. Tests of pogo-stick pumps, which are similar to air-operated sampling pumps, are reported. One such pump was operating after 1200 hr while another operated for over 13,500 hr. Development and operation of a composite deep-well turbine pump, agitator, and sampler are also reported. Operation of a metering pump for continuous proportional sampling for conden-

sate service since 1959 is reported. A discussion is included of the circular peristaltic pump used in the 234-5 hot button line and a HAPO discharge head for deep-well turbine pumps. A HAPO conical, hydraulically operated seal and commercial and HAPO agitators are also discussed. (J.R.D.)

11105 (NAA-SR-Memo-2531(Rev. 1)) DEVELOPMENT OF INELASTIC BENDING RELATIONSHIPS ON THE BASIS OF DIMENSIONLESS STRESS-STRAIN DIAGRAMS. R. D. Chipman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 11, 1958. 34p.

A study was made to derive stress-strain-moment-rotation-deflection relations for materials exhibiting inelastic as well as elastic behavior. General relations are obtained on the basis of Ramberg-Osgood dimensionless stress-strain diagrams. Procedures are outlined for reducing actual material stress-strain diagrams to dimensionless form for comparison with theoretical Ramberg-Osgood diagrams. Procedures are also outlined for determining moment, rotation, and defection characteristics of actual materials and configurations. (W.L.H.)

11106 (SCR-235) HOT-AREA CONCEPT FOR RADIATION TEST FACILITIES. J. L. Colp (Sandia Corp., Albuquerque, N. Mex.). Dec. 1960. 20p. (TID-7599(p.13-23))

The hot-area concept, that of a large, shielded, hot analysis area 60 by 100 ft instead of the usual several small hot cells, is used in the design of the Sandia Engineering Reactor Facility (SERF). The shielding wall along this hot area contains six shielding windows and master-slave manipulator positions. Development of the hot-area concept required parallel development of a means of remotely moving radioactive objects about the area. This requirement led to the construction of a robot mobile remote handler equipped with two mechanical arms and two television camera eyes. A robot fork truck and robot radio-controlled tug are also used. In addition to lower costs of construction and operation, the hot area offers distinct advantages of convenience, flexibility, and safety over conventional hot-cell plans. (auth)

11107 (SCTM-29-60-(81)) LEAKAGE FROM PRESSURIZED CONTAINERS DURING LONG TERM STORAGE. A. N. Blackwell (Sandia Corp., Albuquerque, N. Mex.). Jan. 1, 1961. Contract AT(29-1)-789. 23p.

Concern for the protection of water-sensitive components by storage in pressurized containers prompted this study of leakage from pressurized containers. Work carried out to determine leakage rates, which will ensure a positive pressure within the container for a specified storage period, is summarized. These analyses considered molecular flow and two cases of viscous flow through physical gaps or holes in the container. (auth)

11108 (WADD-TR-60-675) BASIC RESEARCH AND DEVELOPMENT IN FLUID POWER CONTROL FOR THE UNITED STATES AIR FORCE. Fourth Progress Report. (Massachusetts Inst. of Tech., Cambridge). Sept. 1960. 74p. Contract AF33(616)-6120. Project No. 8225, Task 82184.

Research and development work is reported on vital problems encountered in providing high performance hydraulic and pneumatic control systems for advanced system design and development. Increased emphasis on high-pressure pneumatic components and systems reflects approach to an ultimate objective of employing hot gas power to operate such systems. Control valves, servomotors, gas bearings, and techniques of control are the major items discussed. (auth)

11109 (DEG-Inf.-Ser.-36) DESIGN AND CONSTRUCTION OF SATURATED-STEAM TURBINES. F. Schmiedel. Translated by R. Presser from Atomkernenergie, 3: 498-504(1958). 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 5969.

11110 HOLDUP IN LIQUID-LIQUID EXTRACTION COLUMNS. A. I. Johnson and E. A. L. Lavergne (Univ. of Toronto). Can. J. Chem. Eng., 39: 37-41(Feb. 1961).

A theoretical study of the countercurrent flow of a dispersed phase in a continuous phase resulted in the following equation relating holdup X to the flow rates of the two phases: $[A(U_C/U_D)^{2-n}(X/1-X)^3 + B = X^3/U_D^{2-n}]$. For packed towers this equation was used in the following form: $[X^3/U_D^{1.5} = A'(U_{Cr}/U_D^{1.5})(X/1-X)^3 + B']$. Values of A', B', and r for three liquid pairs, and two packing types are reported, using new holdup data. Graphical correlations are shown, and values of r are reported for some of the data of Gayler and Pratt. For spray towers, the equation suggested a correlation of $X^3/U_D^{1.8}$ against the group $[U_C^{0.2}/U_D^{1.8}\ (X/1-X)^3]$. This was tested using data previously published by one of the authors. (auth)

11111 STRESSES IN THIN-WALLED PRESSURE VESSELS WITH ELLIPSOIDAL HEADS. H. Kraus, G. G. Bilodeau, and B. F. Langer (Westinghouse Electric Corp., Pittsburgh). J. Eng. Ind., 83: 29-42(Feb. 1961).

A finite difference approximation to the Love-Meissner equations for the ellipsoidal shell was used to calculate stresses in thin-walled pressure vessels with ellipsoidal heads. Calculations were made with a digital computer for a useful range of the shell parameters. Results are reported in the form of stress indexes and stress intensity indexes, the latter based on the maximum shear theory of failure. Comparisons are made with the available experimental and analytical work in the literature, and stresses are also given for typical heads designed in accordance with the ASME Boiler and Pressure Vessel Code. (auth)

11112 TUBULAR PASSAGE CLOSURE. (to Atomic Energy of Canada, Ltd.). British Patent 860,013. Feb. 1, 1961.

A simple and effective method of closing a tubular passage was developed which will withstand repeated opening while maintaining its sealing effect and which can be employed when its use would not allow the presence of an organic sealant material. The closure device is made up of a hollow cylindrical body that can be inserted in the passage. A rod is mounted for axial movement in the cylinder and a concave-convex disk is attached to the inner end of the rod. The disk may be radially expanded in response to pressure. Covering the outer surface of the disk is a cup of soft metal. The assembly of the cup and disk in its original form has a radius of a little less than that of the passage. In its expanded form, the radius of the assembly tends to exceed that of the passage, forcing a seal to be established. (M.C.G.)

11113 IMPROVEMENTS IN OR RELATING TO ROLLER BEARINGS. Frederick William Tompkins, Herbert Chilvers Knights, and William Rodwell (to United Kingdom Atomic Energy Authority). British Patent 860, 166. Feb. 1, 1961.

A roller bearing consisting of a roller assembly acting between two bearing plates including at least two cylindrical rollers linked in parallel and a locating member on the roller assembly to oscillate with the rollers as the bearing plates moving relative to one another is described. This type of roller bearing can be used to support heavy-

pressure wheels containing hot fluids since they can allow radial and longitudinal expansion and contraction without putting additional strain on the vessel. The bearing can also be used to support large vessels or weights in a moving body where movement of the body might cause the bearing plates to move apart. If this should happen the roller assemblies would be held captive and in their correct position by locating pins. (M.C.G.)

11114 IMPROVEMENTS IN THE DRIVING ARRANGEMENTS FOR FEEDING CUT TOBACCO TO CIGARETTE MAKING MACHINES. Gordon Francis Wellington Powell (to Molins Machine Co , Ltd.). British Patent 860,185. Feb. 1, 1961.

Equipment is described for adjusting the speed of tobacco feed to cigarette making machines in response to variations in feed mass detected by a radiation gage. The equipment consists of an electric control circuit associated with the gage, a tobacco feed driving mechanism employing a stepless variable gear, a gear regulating device, an electric motor coupled to the regulating device, and a slippable clutch interposed between the motor and the gear regulating device. (D.L.C.)

Heat Transfer and Fluid Flow

11115 (AD-238118) HEAT TRANSFER CHARACTERISTICS OF SULFUR AND OF SULFUR DILUTED WITH HYDROGEN SULFIDE FLOWING THROUGH CIRCULAR TUBES (thesis). Porter Walwyn Stone (Texas. Argicultural and Mechanical Coll., College Station). May 1960. 66p.

A comparative analysis was made of the heat-transfer characteristics of pure sulfur and of sulfur diluted with various concentrations of hydrogen sulfide, using water as a basis of comparison. For identical tube sizes and the same fluid velocity, both pure and dilute sulfur were found to have a film conductance less than 10% of that of water over most of the temperature range investigated (250 to 680°F). A procedure was outlined for using data from the characteristic curves to design a sulfur heat-exchange system that will transfer heat at the same rate as an existing water heat-exchange system. The feasibility of using pure or dilute sulfur as a reactor coolant was discussed. Pure sulfur was found to be too viscous over most of the range below 600°F to be suitable as a coolant. Investigation of the effect of dilution revealed that the viscosity could be sufficiently reduced to allow the use of sulfur over all the temperature range. (auth)

11116 (AD-238468) MODIFICATION OF A FORCED CONVECTION HEAT TRANSFER LOOP FOR USE WITH BINARY MIXTURES (thesis). Paul Arthur Butler (Oklahoma State Univ., Stillwater). May 1960. 50p.

A project to determine the heat-transfer and pressure-drop characteristics during boiling of a binary mixture in a forced-convection heat-transfer loop is described. A previously used loop was employed, and a description of the modifications of the loop and the results of the modifications are presented. Thermocouple and orifice calibrations for the loop are described. (J.R.D.)

11117 (ANL-6251) A STUDY OF THE VARIATION OF STEAM VELOCITY IN VERTICAL BOILING CHANNELS. (General Nuclear Engineering Corp., Dunedin, Fla.). November 1960. 69p. For argonne National Lab., Ill. Contract W-31-109-eng-38, Subcontract 31-109-38-757.

An analysis was made to correlate experimental boiling heat-transfer data with the variable relative velocity ($C_s - C_L$). The correlation was based on a boiling model or mechanism. The range of variables encountered included pressure, water velocity, power density, subcooling, steam-volume fraction, steam quality, and channel distance. Forced and natural circulation tests were investigated. Results are reported. (W.L.H.)

11118 (APAE-78(Vol.I)) INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR FINAL DESIGN. THERMAL AND MECHANICAL DESIGN. (Alco Products, Inc., Schenectady, N. Y.). Sept. 30, 1960. 382p. Contract AT(11-1)-666.

The final designs are given for a sodium-to-sodium intermediate heat exchanger and a sodium-to-water steam generator. The basic design of the heat exchanger is a shell with fixed tube sheets and sine wave tubes; this offers the advantage of tubes operating essentially independently of the shell or adjacent tubes. The steam generator is designed basically as a shell-and-tube unit made of three sections: (1) a boiler section, (2) a steam drum, and (3) a superheater section. A thermal design analysis is given for the steam generator. Fabrication concepts are outlined for the heat exchanger and steam generator. The design data and drawings are presented. Mechanical and thermal design calculations, developed during the final design phase, are included. Cost estimates were prepared for the heat exchanger, boiler section, and superheater section for 30- and 70-Mw capacity. (B.O.G.)

11119 (APAE-78(Vol.II)) INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR FINAL DESIGN. CHEMICAL AND STRESS ANALYSIS. (Alco Products, Inc., Schenectady, N. Y.). Sept. 30, 1960. 450p. Contract AT(11-1)-666.

Chemical and stress analyses were made of a sodium-to-sodium intermediate heat exchanger and a sodium-to-water steam generator as an extension and modification to previous analyses. The chemical analysis covers the sodium cover-gas system and the effects of sodium water reactions in the event of a leak in the steam generator. The stress analysis was made of those thermal transients that would be physically possible with the intermediate heat exchanger and steam generator design. Attention was given to methods of operation that would minimize the magnitude and frequency of thermal shocks. A structural design basis is included for handling stress analysis of combined mechanical, hydrostatic, and thermal stresses. Conditions for using creep and stress rupture properties are given. (B.O.G.)

11120 (APAE-78(Vol.III)) INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR FINAL DESIGN. SPECIFICATIONS. (Alco Products, Inc., Schenectady, N. Y.). Sept. 30, 1960. 90p. Contract AF(11-1)-666.

Twenty-three material, inspection, and welding specifications are presented for the various parts of the intermediate heat exchanger and steam generator. Tables are given to indicate the applicable parts and assemblies to which the specifications apply. (B.O.G.)

11121 (CEA-1591) DÉTERMINATION EXPÉRIMENTALE EN SIMILITUDE DE L'INFLUENCE DE PERTURBATIONS DANS L'EPAISSEUR D'UN CANAL CHAUFFANT SUR LES TEMPERATURES DE LA PAROI ISOLÉE. (Experimental Similitudes Determination of the Influence of Perturbations in the Thickness of a Heating Channel on the Isolated Wall Temperatures). Ph. Vernier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 26p.

A study was made of the local heating phenomena produced on the isolated wall of a channel heated by the Joule effect by a sudden fluctuation in the conducting thickness. By the use of an experimental scale model it was possible to

measure the differences in the isolated wall temperature along the abscissa of the perturbation. The tests carried out show that the temperature differences are contained within a range of ±4% with respect to the temperature differences between the isolated and the cooled walls. (auth)

11122 (CF-60-7-119) CONCENTRATION GRADIENTS IN AQUEOUS THORIA SLURRIES FLOWING AT 280°C IN A 3 IN. HORIZONTAL PIPE. A. N. Smith (Oak Ridge National Lab., Tenn.). July 18, 1960. 54p.

The vertical concentration distribution of an aqueous thoria slurry flowing in a 3 in. IPS horizontal pipe at 280°C was determined for various concentrations and linear velocities using the gamma attenuation technique. The concentration gradient was directly proportional to the temperature and inversely proportional to the linear velocity and slurry concentration. Dropout (stationary bed of solids) may have occurred at 3.2 ft/sec at concentrations up to 900 g of ThO_2/l slurry, although conclusive evidence is lacking. Settling unit sizes of as much as 120 μ may be inferred from the data. An empirical formula was developed relating concentration gradient and linear velocity at 280°C. The fit at 260 and 240°C, however, was poor. A steep concentration gradient was noted at 370 g of ThO_2/l slurry at 3.2 ft/sec. The Reynolds number, $D^V\rho/\eta$, at these conditions was 110,000 or three times the value which the Hedstrom plot predicts for entry into turbulent flow. Attempts to apply the data to various theoretical equations (relative to settling rate and diffusivity) were inconclusive. (auth)

11123 (CF-60-12-67) STEADY-STATE RADIAL AND AXIAL TEMPERATURE PROFILES OF AN E.G.C.R. 5½" O.D. THROUGH TUBE DURING 1500 KW OPERATION. PART II. L. W. Noggle (Oak Ridge National Lab., Tenn.). Dec. 30, 1960. 27p.

The steady-state radial- and axial-temperature profiles of an EGCR 5½-in. OD through tube are determined for the test condition of an attemperated fuel assembly operating at 1500 kw in the loop. The profiles are determined for the case of the central control rod fully inserted and bank insertion to 62 in. ($\Delta k = 0.025$). The data are presented in the form of tables and curves. (auth)

11124 (CF-61-2-33) GENERALIZED HEAT CONDUCTION CODE FOR THE IBM-7090 COMPUTER. T. B. Fowler (Oak Ridge National Lab., Tenn.). Feb. 9, 1961. 4p.

The IBM-704 code GHT was programmed for the 7090 computer, to be run under control of the IBM-7090 FORTRAN Monitor System. By eliminating the use of tapes for intermediate number storage, it was possible to reduce computing time by a factor of 26 over the 704. A minimum of three tapes are required; one for input, one for output, and the System tape. One scratch tape is required for transient problems, and one punch tape is required if the steady-state temperature distribution is to be punched on cards. (auth)

11125 (DMIC-Memo-78) METHODS OF MEASURING EMITTANCE. W. D. Wood, H. W. Deem, and C. F. Lucks (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). 22p. (PB-161228).

References covering the methods and equipment used in emittance measurements in the field of radiant heat transfer are presented. (W.L.H.)

11126 (GEAP-3628) PREDICTION OF TWO-PHASE FLOW FROM MIXING LENGTH THEORY. S. Levy (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 27, 1960. Contract AT(04-3)-189. 53p.

Single-phase turbulent mixing length methods are used to predict two-phase flow. Two-phase density and velocity distributions and two-phase pressure drops are derived by treating the two-phase system as a continuous medium where the turbulent exchanges of momentum and density are equal. The solution, which parallels that of single-phase flow, indicates that the density and velocity distributions are of the power type and their exponent varies with total liquid Reynolds number, mean fluid density, and channel geometry. The calculated profiles are much more curved than in single-phase flow and agree with the density distributions measured by Petrick. The two-phase pressure drop in horizontal flow is a function of total liquid Reynolds number and mean fluid density; in vertical flow, it also depends upon the equivalent total liquid velocity head. The ratio of two-phase pressure drop to total liquid pressure drop decreases as the total liquid Reynolds number increases or as the channel geometry changes from horizontal to vertical or from pipe to parallel plates. Available low- and high-pressure data in horizontal and vertical channels confirm the predicted trends. Good agreement is obtained between test and analytical two-phase pressure losses at high flow and mean fluid density. The predicted values are, however, low at reduced flow and mean fluid density. This discrepancy is attributed to the approximate treatment presently used near the channel wall. Improved solutions patterned after those of single-phase flow with variable fluid properties are expected to improve the correlation between tests and analysis. According to the present analysis, local slip must exist between liquid and gas at every position in the flow channel. The proposed model reduces a two-phase problem to an equivalent one in single-phase flow. It can be extended to predict such effects as film boiling, entry length, and heat transfer in two-phase flow. (auth)

11127 (JPL-TR-32-47) A FORCED-CONVECTION AND NUCLEATE-BOILING HEAT-TRANSFER TEST APPARATUS. Paul F. Massier (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Mar. 3, 1961. Contract NASw-6. 28p.

For most liquid propellants used in rocket engines, the ability to cool thrust-chamber walls locally is established by the upper limit of nucleate boiling. An experimental apparatus utilizing electrically heated tubes to obtain boiling heat-transfer characteristics of numerous propellants is described. The effects of deposition and electrically conducting fluids on heat-flux measurements, as well as precautions that must be considered when testing monopropellants, are discussed. Comparisons are made of variable-property and constant-property equations for computing temperature difference across an electrically heated tube wall. (auth)

11128 (NASA-TN-D-586) AN ANALYSIS OF THERMAL RADIATION HEAT TRANSFER IN A NUCLEAR-ROCKET NOZZLE. William H. Robbins (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Jan. 1961. 25p.

A calculation procedure was developed for determining the radiant heat flux along a nuclear-rocket nozzle wall. The results of calculations of heat flux are presented for a wide range of nozzle geometries, reactor-face temperatures and emissivities, and nozzle-wall temperatures and emissivities. Since the heat-flux calculations were somewhat laborious, an approximate method for obtaining the radiant-heat-flux distribution for similar nozzles by a relatively simple interpolation procedure was also developed; and reasonably good agreement between the calcula-

tion procedure and the interpolation method was obtained. (auth)

11129 (PIBAL-585) A NOTE ON THE APPLICATION OF THE HEAT BALANCE INTEGRAL TO PROBLEMS OF NON-PLANAR GEOMETRY. Thomas J. Lardner and Frederick V. Pohle (Brooklyn. Polytechnic Inst.). Jan. 1961. 23p. Contract AF 49(638)-302. (AFOSR-57)

The temperature distribution in the region exterior to a cylindrical hole in the infinite space with a boundary that is exposed to a constant heat flux was determined using the integral method with a parabolic profile. The results indicated that the use of the parabolic spatial temperature distribution led to poor agreement with the exact solution. A modified profile was introduced, and was found to lead to better agreement. The analogous problem for the spherical cavity was treated. (auth)

11130 (SCTM-358-60(71)) GRAY BODY RADIATION EXCHANGE IN AN ENCLOSURE. J. A. Wiebelt (Sandia Corp., Albuquerque, N. Mex.). Nov. 1960. 8p.

Gray body radiant heat transfer between two surfaces is a function of the geometrical arrangement of the surfaces, their emissivities, and their temperatures. A method is described for evaluating "radiosities" and solving the problem on either an analog or digital computer. (auth)

11131 (TID-11622) FLUID-SOLID HEAT TRANSFER STUDY. Progress Report. (Report No. 1). Robert S. Brodkey (Ohio State Univ. Research Foundation, Columbus). Dec. 1960. 25p. Project No. 929. Contract AT(11-1)-774.

A literature survey was conducted to obtain information on fluidization. Attempts are made to reveal the nature of the different reported values of heat-transfer coefficients, and a critical appraisal of the reliability of some of the values is included. A general description of the fluid-bed system is given, and gas fluidization is discussed. Fluid-particle heat transfer in fluidized beds is also discussed. The objectives of experimental work include determination of local fluid-particle heat-transfer coefficients. In these studies, steady-state experimental conditions are chosen to eliminate the complexity of analysis involving time. A rectangular bed configuration is to be used. Probes for temperature measurements are also described. 22 references. (J.R.D.)

11132 (UCRL-8733) COALESCENCE AND DISPERSION RATES IN AGITATED LIQUID-LIQUID SYSTEMS (thesis). James Hidde Vanderveen (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1960. Contract W-7405-eng-48. 58p.

A study was conducted to determine the variables affecting the coalescence of droplets after they leave the impeller tip. The resulting correlation shows that the mean drop diameter at any position in a stirred tank can be expressed as the sum of the equilibrium drop diameter and an incremental coalescence term that is a function of viscosities, densities, volume fraction, and Weber and Reynolds numbers. The rate of dispersion of a dye soluble only in the dispersed phase of an agitated liquid-liquid mixture has also been found to be a function of Weber and Reynolds numbers. (auth)

11133 DESIGN OF HEAT EXCHANGERS FOR NUCLEAR POWER PLANTS. B. F. Ridal and J. H. Wilson (Simon-Carves, Ltd., Cheadle Heath, Stockport, Ches., Eng.). Chem. & Process Eng., 42: 55-8(Feb. 1961).

Since the formation of the nuclear power consortia in 1955, a number of developments in heat exchangers have resulted in considerable economies both in capital and generation costs. Some factors affecting mechanical design, such as gas velocities and bypassing of finned sections, are discussed. A general description is given of the conditions that must be met in the thermal design of such heat exchangers, and experimental techniques for obtaining reliable heat-transfer data are mentioned. Details of an experiment designed to justify the use of theoretical analysis of fin efficiency are presented. (auth)

11134 CERAMIC HEAT EXCHANGERS FOR HIGH-TEMPERATURE HEAT TRANSFER FROM HELIUM. Stanley C. Browning and John J. S. Sebastian (U. S. Bureau of Mines, Morgantown, W. Va.). Ind. Eng. Chem., 53: 191-6(Mar. 1961).

Research was undertaken to develop a ceramic heat exchanger to operate at high temperatures for utilizing nuclear heat from gas-cooled process heat reactors. The transfer of heat from helium flowing through a single-tube vitreous alumina heat exchanger was studied. Inside film coefficients were determined at mean surface temperatures of 200 to 1570°F, inlet gas temperatures of 1450 to 2665°F, and Reynolds numbers up to 560. The gas-to-surface temperature ratio was varied from 1.05 to 7.6. The Nusselt number for the lower laminar region decreased as the ratio of gas-to-wall temperature was increased. This relationship is expressed by an equation involving dimensionless groups. Ceramic heat exchangers show considerable promise at higher temperatures but are limited to low pressures. Their technical feasibility depends on developing reliable gas-tight seals and eliminating high thermal stresses. (auth)

11135 CONVECTION HEAT TRANSFER COEFFICIENTS FOR TURBULENT FLOW BETWEEN PARALLEL PLATES WITH UNEQUAL HEAT FLUXES. Henry Barrow (Univ. of Liverpool). Intern. J. Heat and Mass Transfer, 1: 306-11(Jan. 1961). (In English)

A semi-theoretical analysis of asymmetric heat transfer in fully developed two-dimensional turbulent flow between parallel walls is presented. An extension of the analogy between the transfer of heat and the transfer of momentum (due to Mizushina) was used to determine the heat-transfer coefficients for the respective boundaries. The results of the analysis are presented in the form of working formulas from which the relative magnitudes of the heat-transfer coefficients may be determined. The formulas may be applied to practical engineering problems, but care is necessary because the assumptions made in the theory impose restrictions on the Prandtl and Reynolds number ranges for which the predictions are acceptable. It was immediately obvious from the graphical presentation of the results for a particular fluid that the heat flux ratio is an important additional parameter and that cognizance of this should be taken in cases of nonuniform heating. By its nature the analysis is preliminary, and an experimental program was devised to study the general problem of asymmetric heat transfer and to test the theory. While channel flow was considered, the results are thought to be valid for axisymmetric flow in annuli with small outside diameter/inside diameter ratios. (auth)

11136 AN ANALYSIS OF LAMINAR FILM BOILING WITH VARIABLE PROPERTIES. P. W. McFadden and R. J. Grosh (Purdue Univ., Lafayette, Ind.). Intern. J. Heat and Mass Transfer, 1: 325-35(Jan. 1961). (In English)

An analysis was made of stable, laminar, free convection, film boiling from isothermal vertical plates and horizontal cylinders surrounded by a saturated liquid. The mathematical techniques of boundary-layer theory were used and the boundary-layer equations were reduced to ordinary differential equations by means of a transforma-

tion similar to that used in free convection and condensation. The equations were solved for compressible flow with variable specific heat. Numerical results are presented for near critical water at 2800 and 3100 lb/sq in. with wall-to-liquid temperature differences of 250, 500, and 1000°F. Results for heat transfer, velocity distribution, and temperature distribution are included and compared to solutions obtained by assuming constant properties. (auth)

11137 A NOTE ON GROUP VELOCITY. G. B. Whitham (Massachusetts Inst. of Tech., Cambridge). J. Fluid Mech., 9: 347-52(1960). (AFOSR-TN-60-140)

The kinematic approach to group velocity given in Lighthill & Whitham (1955) for one-dimensional waves is extended to cover the general three-dimensional case. The ideas have particular bearing on the theory developed by Ursell (1960) for treating steady wave patterns on nonuniform steady fluid flows. (auth)

11138 CERTAIN NON-STATIONARY PROBLEMS OF HEAT TRANSFER BY RADIATION. I. V. Nemchinov. Zhur. Priklad. Mekh. i Tekh. Fiz., No. 1, 36-57(May-June 1960). (In Russian)

Equations of nonstationary heating and cooling processes were investigated, together with those defining motion of the medium. The radiant heat-transfer equations were found to be not completely hyperbolic, and the boundary conditions for both moving and motionless boundaries were determined for the presence and the absence of a sudden change of the temperature, considering also linear correlations under ordinary heat-conduction processes. The study also included problems in which the course of gradual radiation depends on the temperature, whereas the radiant flux is a function of time. Numerical computations are included for solving nonlinear equations under quasi-stationary conditions involving boundary cases which yielded analytical expressions for the temperature distribution and the heat flux. (TTT)

11139 FLOW OF GASES WITH HIGH HEAT CONDUCTIVITY IN THE VICINITY OF THE CRITICAL POINT OF A BLUNT BODY. A. M. Klimov. Zhur. Priklad. Mekh. i Tekh. Fiz., No. 1: 138-41(May-June 1960). (In Russian)

Fluids with a high heat conductivity, such as ionized gases and liquid metals, have a small Prandtl number σ. If the Peclet number of the system is sufficiently high to satisfy the conditions set for the boundary layer, while the Prandtl number is much smaller than unity, then in first approximation the temperature boundary layer may be regarded as being nonviscous, the dynamic boundary layer considered as being isothermal across the thickness of the layer and behaving as a surface heat source. Applying these considerations, the problem of heat transfer near the critical point at arbitrarily chosen Prandtl numbers was examined. Results of the calculation showed that the heat transfer in an ionized gas may be increased by more than $1/\sqrt{\sigma}$ times the heat transfer in the un-ionized gas, assuming that no chemical reaction takes place. (TTT)

11140 HEAT TRANSFER SYSTEMS. George Clifford James Dalton and George Edward Lockett (to United Kingdom Atomic Energy Authority). British Patent 860,561. Feb. 8, 1961.

A heat-transfer system is described for heat conduction from heat-generating solid materials, particularly solid reactor fuel elements, to a cooling fluid. The system comprises heat-generating materials traversed in the direction of the major temperature gradients by heat conductors of relatively high thermal conductivity. A reactor fuel element formed according to this system consists of fissile disks of plutonium plated with copper stacked in a stainless-steel tube with upper and lower plugs; liquid sodium is sealed into the tube with the disks to function as a protective jacket which prevents fission products from entering the coolant. (D.L.C.)

11141 HEAT EXCHANGERS. Charles Michael Buchanan Russell (to Nuclear Power Plant Co., Ltd.). British Patent 861,060. Feb. 15, 1961.

A tubular heat exchanger is designed for use in conjunction with gas-cooled reactors. In the exchanger the tubes are arranged in banks within a shell with the banks formed as open-ended boxes of sector or truncated sector cross section arranged axially around the central axis of the shell. This arrangement is designed so that the gas coolant and secondary fluid flows are chiefly parallel to each other and in counterflow relation. In a dual-pressure system, the high-pressure steam circuit banks alternate with the low-pressure steam circuit banks. The advantages of this heat-exchanger design are that the tube bank boxes can be prefabricated, the work on site during erection of the heat exchanger is reduced, and the number of shell penetrations by inlet and outlet ducts is reduced. (D.L.C.)

Instrumentation

11142 (60-RL-2501 G) A SMALL, SENSITIVE, BAKEABLE MASS SPECTROMETER. W. D. Davis and T. A. Vanderslice (General Electric Co. Research Lab., Schenectady, N. Y.). Sept. 1960. 29p.

A small, portable, magnetic, deflection type mass spectrometer with a secondary emission multiplier was built for studying residual gases at ultrahigh vacua and making transient pressure studies. Because of its small size it has the advantage that it can be sealed directly to the tube or system being investigated, and is easily transportable. The spectrometer may be baked out at 450°C. The design consists of a 90° sector, 5-cm radius of curvature magnetic analyzer which will resolve adjacent mass peaks to about mass 140. A Nier-type ion source is used and the ion detector is a 10-stage DuMont, No. 6467 electron multiplier with a gain of 10^7. Partial pressures of 10^{-13} mm Hg were measured under normal operating conditions. By cooling the multiplier in liquid nitrogen, pressures of the order of 10^{-15} mm Hg are measurable. Using the multiplier, the signal level is raised to a point at which a low output load resistance may be used to get a short response time. This makes it possible to scan a large mass range and display the spectrum on an oscilloscope. Different ion species may thus be observed almost simultaneously during the course of transient phenomena. Sweep rates as high as 1.5 μsec per mass unit were used sucessfully. (auth)

11143 (AD-237992) SILICON JUNCTION RADIATION DETECTOR. QUARTERLY REPORT NO. 3 COVERING PERIOD FROM DECEMBER 15, 1959 TO MARCH 15, 1960. R. L. Williams and P. P. Webb (RCA Victor Co., Ltd. Research Labs., Montreal). Contract DRB-900102. 21p.

During the 3rd quarter of this project further work was directed along lines of constructing encapsulated nuclear particle detectors. The purpose was to improve the encapsulation already described in the previous quarterly report and to make larger detectors. Encapsulated units were made with detecting areas as large as 2 cm^2, having energy resolutions in the range 4 to 5%. Further measurements were made of energy resolutions of the smaller-sized detectors; and a check was made on reverse leakage currents, from which estimates of the carrier lifetime of

the material can be deduced. Progress was also made toward the manufacture of encapsulated units having much thinner diffused layers than previously reported. Several detectors were made having diffused layers about 0.2 μ deep, and capable of working to voltages of at least 15 volts. Detailed measurements of junction characteristics of both encapsulated and unencapsulated units indicate that their properties are quite well explained by theoretical expressions. A study is also being made of the feasibility of fabricating detectors of the phototransistor type. Units have been made exhibiting high gain. (For preceding period see AD-255729.) (auth)

11144 (AE-44) HAND MONITOR FOR SIMULTANEOUS MEASUREMENTS OF ALPHA AND BETA CONTAMINATION. I. Ö. Andersson, J. Braun, and B. Söderlund (Aktiebolaget Atomenergi, Stockholm). Nov. 1960. 26p.

An instrument is described which measures α and β contamination of the hands simultaneously. This has been achieved by using as detectors eight flow counters paired off in four units of two chambers, one unit for each side of the hand. The inner chamber of every unit (adjacent to the hands) delivers α pulses, and the outer chambers deliver β pulses. When two finger contacts are pushed, the detectors close around the hands and the measurement is started. Audible and visual warnings operate when the maximum permissible level is exceeded. Similar warnings operate if hands are removed before the end of the counting period. The activity levels are logarithmically indicated on four pointer instruments, which are automatically zeroed when the next measurement is started. The instrument is now commercially available. (auth)

11145 (AFBMD-TR-60-104) SEMIANNUAL REPORT ON SPACE PHYSICS INSTRUMENTATION, JANUARY 1, 1960–JUNE 30, 1960. (Space Technology Labs., Inc., Los Angeles.) 57p. Contract AF04(647)-309. (STL/TR-60-0000-09191; AD-242422)

Electron detection experiments with solid-state detectors indicated that by using such detectors as alternates for scintillation detectors in the high-energy β spectrometer, significant savings were effected in space, weight, and power requirements. Fabrication was completed of the laboratory model of a luminescent chamber system for use as a high-energy particle research tool. The luminescent chamber development program includes a feasibility demonstration of the use of the system in space flight. A monoenergetic electron source is being constructed for use in calibration and design evaluation of the high-energy β spectrometer. An ultra-high vacuum dry dock was constructed for use in investigations of current control and monitoring in the low emission gun of the electron accelerator. Design and development of the digital flux-gate magnetometer are complete except for those requirements made necessary by specific applications. Development of the search coil magnetometer carrier amplifier continued with the fabrication of a precision rectifier, a transistorized chopper-modulator, and a precision attenuation test unit. Construction of test jigs, the breadboarding of high impedance circuitry, and prototype electric field sensors for a proposed electric field meter were completed. The prototype electric field meter system is nearly ready for final checkout. (auth)

11146 (AFOSR-TN-60-1171) NOISE IN BACKWARD-WAVE AMPLIFIERS. H. Jory (California. Univ., Berkeley. Electronics Research Lab.). July 25, 1960. Contract AF 49(638)-102. 176p.

The backward-wave amplifier, a type of traveling wave tube, is studied from the point of view of the current and velocity fluctuations that are present in the electron beam and which produce electrical fluctuations or noise in the output of the device. The work is concerned with tubes employing the tape-helix interaction circuits and hollow cylindrical electron beams normally found in backward-wave amplifiers. An analysis is presented which demonstrates that this type of amplifier involves an infinite set of beam waves having one phase variation in angle, but different radial variations. The relative coupling between the helix and the various radially-varying beam waves is determined. The relative excitation of the beam waves is also calculated for typical noise pulses of finite width. An experimental system designed to measure that part of the noise which couples to the backward-wave amplifier is described. Measurements with two types of operating conditions near the cathode are discussed. For one regime the beam-forming electrode (BFE), located behind the cathode, is at cathode potential. For the other regime, which results in lower noise figures, the BFE is at a positive potential. The lowest measured noise figure is 4.8 db with a BFE voltage of 4.5 volts, a beam current of 1 ma, and again of 4.3 db. The measurements of noise power are used to obtain an estimate of the ratio Π/S, where Π is a measure of correlation between current and velocity fluctuations, S is a noisiness parameter, and the minimum noise figure is proportional to $(S-\Pi)$. Measurements of noise power out of the helix are interpreted also in terms of a noise admittance on the beam. The experimentally determined admittance is transformed back along the beam, toward the cathode, and compared with calculated values at the first anode and at the potential minimum. Measured values show good agreement with each other but not with the calculations. Experimental results near the crossover point, where the same helix and beam can be used either as a backward-wave or a forward-wave amplifier, are described. The results indicate no significant differences in the beam noise exciting the two types of amplifiers. (auth)

11147 (ARF-1152-12) AN IMPROVED NUCLEAR MEASURING PRINCIPLE. Final Report for Period Covered June 5, 1959–June 5, 1960. G. M. Burgwald and C. A. Stone (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Aug. 1, 1960. 47p. Contract AT(11-1)-745.

Because of stability considerations, the scintillation counter has not found use in industrial mass gaging systems. Advantages such as high detection efficiency and rapid response have prompted investigation of a technique which essentially cancels variations in scintillation counter sensitivity. The detector alternately views radiation transmitted through the sample and through a calibrated step wedge, any difference in intensity causing a servo to reposition the wedge until balance is achieved. Long-term accuracies of $\sim 0.5\%$ were achieved during test intervals. The use of Ross filters for mechanical energy discrimination were investigated, and the technique has several possible applications in the gaging field. (auth)

11148 (ARL-TR-60-330) HIGH PRESSURE PHYSICS. P. Gibbs, G. S. Baker, K. L. DeVries, J. R. Galli, M. R. Jones, and J. L. Seely (Utah. Univ., Salt Lake City). Sept. 1960. 46p. Contract AF33(616)-5016.

An apparatus for producing and measuring pressures to 20,000 atm using a liquid or gas environment was constructed and tested. The pressure chamber has a working space 1-in. in diameter by 4-in. long, and is designed for use with internal heating to 1000°C. A new type plug was designed and tested allowing 8 electrical leads to be brought into the pressure chamber. A torsional pendulum for measuring internal friction inside the pressure vessel

was constructed and instrumented. Damping measurements on ~0.06-in. diameter wire specimens can be made over a strain amplitude range of $\epsilon = 10^{-6}$ to 10^{-4}. Provision is made for an internal furnace heating the specimen over a wide temperature range. A creep apparatus was constructed and tested. Preliminary results on tin have shown a definite slowing down of creep because of the application of pressure. An activation volume for the process is estimated. (auth)

11149 (BM-RI-5726) LABORATORY-SCALE CASTING FURNACE FOR HIGH-MELTING-POINT METALS. P. G. Clites and E. D. Calvert (Bureau of Mines, Washington, D. C.). 1961. 16p.

Development and design of a laboratory furnace are described. The furnace incorporates a consumable electrode and is equipped with a water-cooled copper ladle. Applications and performance of the furnace are discussed, and data are included on casting of copper, titanium, zirconium, hafnium, niobium, molybdenum, tantalum, tungsten, iron, and chromium, and iron-uranium alloys. (J.R.D.)

11150 (CEA-1532) ÉTUDE DE LA FLUORESCENCE DES GAZ RARES EXCITÉS PAR DES PARTICULES NUCLÉAIRES CHARGÉES. UTILISATION POUR LA DÉTECTION DES RAYONNEMENTS NUCLÉAIRES PAR SCINTILLATION. (A Study of the Fluorescence of the Rare Gases Excited by Nuclear Particles. Use of the Principle for the Detection of Nuclear Radiation by Scintillation). Lydie Koch (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 77p.

Thesis submitted to Univ. of Paris.

The properties of atoms excited by the passage of α particles through rare gases at atmospheric pressure are first examined. A spectral analysis of the light emitted showed that certain impurities play an important part in producing the fluorescence. The light emission contains at least two components, a very short-lived one caused by the direct deexcitation of the rare gas and a relatively longer-lived one caused by energy transfer to the impurities. The measurement of the lifetime of the excited states shows that the rapid part of the pulse has a lifetime $<2.25 \times 10^{-9}$ sec in the case of xenon. The long-life component has a duration directly dependent on the nitrogen concentration. The study of the rare gases under the effect of an electric field made it possible to show that the amount of light produced by an α particle can be multiplied so that the luminescent efficiency is greater than that of NaI(Tl). The characteristics of the rare gases acting as scintillators are then examined. The most important characteristic is the absence of saturation when the intensity of the incident excitation is very large. This property, together with the very brief scintillation time, permits the study of some nuclear physics applications (heavy particle energy measurement, kinetic studies on reactors, and neutron spectroscopy). (auth)

11151 (CEA-1598) DISPOSITIF DE CONTROLE CONTINU DE LA RADIOACTIVITE DU DO_2 DE REFROIDISSEMENT DES PILES D.C.C.A.-CO_2. (Instrument for Continous Control of the Radioactivity of CO_2 Coolant in Piles—DCCA—CO_2). L. Fitoussi (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 51p.

An apparatus is described for continuous measurement of CO_2 activity, which can be used on piles cooled by circulation of gas. The first part is devoted mainly to describing the apparatus used and the character of the radioactivity and thermodynamic measurements carried out, and giving the general characteristics of the gas circuit required if the instrument is to be suitably gas-tight. In the second part theoretical calculations are given, particularly on the determination of the ionization current in an ionization chamber with circulating gas. Several parameters enter into this determination, such as the mean path of β particles in the ionization chamber, the linear number of ion pairs formed in the gas by these β particles as a function of their energy, and the temperature and pressure of the gas in the ionization chamber. This part also evaluates the sensitivity areas of the apparatus for measuring the concentrations of radioactive gases such as Ar^{41} and fission gases from U^{235} in the CO_2 coolant. (auth)

11152 (CEA-1658) REGULATION D'UN NIVEAU DE GAZ LIQUEFIE A ± 0,2 mm PRES. (A Constant Level Liquefied Gas Regulator Sensitive to ± 0.2 mm). C. Moreau (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 8p.

This device was designed to maintain a constant level of liquid nitrogen around the adsoprtion bulb used for the determination of specific surface areas by the BET method. The necessity has already been shown of defining carefully the temperature in the bulb and of reducing fluctuations to a minimum. Various apparatus has already been described but it did not offer the sensitivity and the safety in use which was sought. (auth)

11153 (CF-59-8-56) INSTANTANEOUS VELOCITY PROFILE MEASUREMENT BY PHOTOGRAPHY. H. W. Hoffman (Oak Ridge National Lab., Tenn.). Aug. 17, 1959. 15p.

An apparatus is described for using phosphorescent particles to enable photographic determination of qualitative and quantitative instantaneous velocity profiles in flowing liquids. Phosphor and film data are tabulated, and factors to be considered in analysis of the photographs are discussed. (J.R.D.)

11154 (CF-59-11-128) REMOTE MAINTENANCE PROCEDURE REPORT. B. D. Draper and E. C. Hise (Oak Ridge National Lab., Tenn.). Nov. 26, 1959. 28p.

Development of methods and remote tools to place a patch in the Homogeneous Reactor Test (HRT) core vessel is described. The core vessel patch will either seal it or permit only limited transfer of D_2O from the reflector region to the core region. This will allow for return of the HRT to two-region operation without replacing the core vessel. Development of the patch is described, and detailed procedures for the operation are given. (J.R.D.)

11155 (CF-60-12-114) STATUS REPORT ON THE PNEUMATIC TEMPERATURE MEASURING SYSTEM STUDIES FOR THE EGCR. H. M. Hochreiter (Oak Ridge National Lab., Tenn.). Dec. 30, 1960. 8p.

A test program is planned to determine the general range of usefulness and the limitations of the pneumatic temperature probe (PTM) system for measuring gas temperatures, as well as to establish its feasibility for specific applications in the EGCR. The program is to be conducted in two phases: Phase I will cover temperatures to 1800°F, and Phase II will determine a practical upper limit for other applications and establish a minimum practical probe size. A test loop is almost completed which will utilize a high-temperature furnace and a recycling compressor to study the variables involved. A number of probes using sapphire nozzle throats are completed, and testing is to begin shortly. If the sapphire throat mountings prove mechanically stable with large temperature variations, it appears that a major problem in probe design will be overcome. Outlines are given of the principles of operation, estimates of permissible errors, and the Marquardt PTM feasibility tests. (B.O.G.)

11156 (CF-61-1-82) MULTIPLE CONTROLLERS FOR A SINGLE PROCESS. C. H. Weaver (Oak Ridge National Lab., Tenn.). Jan. 25, 1961. 25p.

A multiple controller system for a single process was formulated in block diagram form. For the general case of n controllers and one type of cross coupling, the system equations can be reduced to the standard forms of servomechanism theory. The effects of failure in individual controllers were examined, and it is demonstrated that the system shows considerable promise for both reliability and maintenance without process interruption. An error channel for use with this controller was examined. If both a slow sensor with no zero drift and a fast sensor with significant zero drift are available at the process, the two sensors can be used in conjunction with the error channel to obtain the effect of a fast sensor with zero drift. Specific examples illustrating both systems are presented. (auth)

11157 (CREL-966) A CONTAMINATION MONITOR FOR REACTOR FUEL RODS. V. H. Allen (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Sept. 1960. 26p. (AECL-1107).

An instrument was designed to examine NPD fuel elements to ensure surface contaminations below 0.013 μg of U/cm^2. The complete surface of each element is scanned by α scintillation counters. Seventeen RCA 5819 photomultipliers are mounted in halves of a Lucite block with a channel for the fuel rod. The channel is coated with a ZnS decal. The pulse circuits, gain adjustment, and calibration are described. (T.R.H.)

11158 (DLCS-3150101) NUCLEAR INSTRUMENTATION SOURCE RANGE DETECTORS. CORE 1, SEED 1. Test Results T-641329. (Duquesne Light Co., Shippingport, Penna.). First issue Oct. 7, 1960. 17p.

A test was made to determine the effects of excessive neutron flux and humidity on various BF_3 detectors. Single-element BF_3 detectors were installed in channels A, B, and C. A four-element detector was installed in channel D. Two of the four BF_3 tubes in channel D had their Kovar seals cut in order to determine the effect of humidity. Of the two single-element BF_3 detectors installed in channels A and B and subjected to excessive neutron flux levels, the channel-A detector failed. The channel-B detector appeared to be operating satisfactorily at the completion of the test. The channel-C detector, operated normally and appeared to be satisfactory at the end of the test. Channel-D detectors appeared to have failed since the final applied voltage curve indicated no high-voltage plateau. (W.L.H.)

11159 (DP-401) INDUCTIVELY COUPLED SCANNING SWITCH. Frank P. Caiati (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1959. 13p. Contract AT(07-2)-1.

An experimental ten-channel single-pole scanning switch was built to test the concept of inductive coupling as a method of switching. Optimization of the available electrical parameters permitted the switching of 2-kc/sec signals, as small as 0.5 mv, at a rate of ten points per second. A new mechanical design, together with magnetic shielding between adjacent switch points, would allow higher switching speeds. A long service life would be expected from a switch of this type since no physical contact is made by the switching parts. (auth)

11160 (GAMD-1610) MGCR HOT HELIUM RECIRCULATING BALL SCREW TESTS. F. Liederbach and B. Hawke (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 17, 1960. 11p. Contract AT(04-3)-187. Project 40.

Tests were begun on a recirculating ball screw to determine the characteristics in a helium environment at elevated temperatures. Tests were conducted with a 125-lb weight attached to the ball nut and the screw rotating at 100 rpm, reversing over a 10-in. stroke. Approximately 14,000 cycles, or 280,000 in. of linear nut travel, were accumulated at 300 to 500°F. The use of MoS_2 as a lubricant during the initial 5030 cycles at 300°F resulted in caking and the formation of MoS_3, the action of which became more that of an abrasive. Seizure of the system occurred after 3850 unlubricated cycles and was found to be caused by the failure of a guide-rod retaining nut, thus causing the guide rod to spread and gall against the guide hole in the weight. The unit was repaired and operated successfully at 400°F until termination at a total accumulation of 7415 cycles. Tests at 500°F were discontinued after 37 hr, following failure of a thermocouple. Dimensional checks after the tests indicated negligible wear on the screw and the balls, of the order of 0.0002 to 0.0003 in. No out-of-roundness of the balls was observed, and the only noticeable effect on the screw threads appeared to be local polishing. (B.O.G.)

11161 (GAT-365) THERMOELECTRIC REFRIGERATOR FOR THE LINE RECORDER MASS SPECTROMETER (THEORETICAL DESIGN). P. I. Davis (Goodyear Atomic Corp., Portsmouth, Ohio). Nov. 14, 1960. 23p.

A theoretical discussion of a thermoelectric device for cooling the line recorder chemical trap is presented. For such a device semiconductor materials are employed to do the heat pumping. The materials considered are lead telluride (PbTe) and bismuth telluride (Bi_2Te_3). Also included are a brief treatment of semiconductor thermoelectric theory and design calculations for a single-stage and a two-stage refrigerator. At present a lead telluride unit appears impractical, and a bismuth telluride unit appears too costly. A recommendation is made to delay the construction of a thermoelectrically cooled chemical trap. Meanwhile, a bismuth telluride refrigeration unit should be perfected for other uses. (auth)

11162 (HW-65738) USE OF ISOLATED JUNCTION SHEATHED THERMOCOUPLES FOR MODERATOR TEMPERATURE MEASUREMENTS. D. B. Lovett (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 16, 1960. Contract AT(45-1)-1350. 6p.

The calculated temperature error that an isolated junction thermocouple would have compared to an integral junction thermocouple is shown. This error can be balanced against the added advantages inherent in an isolated junction couple; such as ungrounded leads, shielded leads, ability to measure insulation resistance, pure sheath material unalloyed with the thermoelements at the hot junction, etc. Calculations indicate that the temperature errors due to the thermal insulation of the hot junction in an isolated junction-sheathed thermocouple of reasonable size are small. (W.L.H.)

11163 (JINR-P-476) GAZOVYE POROGOVYE CHERENKOVSKIE SCHETCHIKI DLYA RABOTY NA USKORITELYAKH. (Gas Threshold Cherenkov Counters Operating with Accelerators). A. Belyakov, A. Vovenko, A. Kirillov, B. Kulakov, A. Lyubimov, Yu. Matulenko, and I. Savin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1959. 9p.

The efficiencies of two types of gas threshold Cherenkov detectors were found to be near unity. The separation of particles in an accelerator beam from the strong background of slow particles was achieved. (tr-auth)

11164 (JINR-P-487) AMPLITUDNYI KONVERTOR DLYA SNYATIYA MNOGOMERNYKH SPEKTROV. (Amplitude Converter for Recording Multidimensional Spectra). B. E. Zhuravlev, G. I. Zabiyakin, and I. V. Shtranikh (Joint

Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1960. 24p.

The design of a multispectra (amplitude-time) device, consisting of a 20-channel selector, fast converter, and 128-channel analyzer, is described. The design of the fast converter is included. Dead-time in the amplitude analysis is 0.1 to 0.2 μsec. (tr-auth)

11165 (KAPL-M-DMW-1) RECOMMENDED DESIGN CRITERIA, HIGH PRESSURE WATER LOOP INSTRUMENT, ELECTRICAL AND CONTROL SYSTEMS. D. M. Wilsey (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 14, 1961. 14p. Contract W-31-109-Eng-52.

An outline of electrical and instrument design criteria for irradiation test loop application is presented. The recommendations were gathered from experience with the design, construction, and operation of water loops at test reactors. (M.C.G.)

11166 (KAPL-M-WRP-5) A RAPID ANALOG TO DIGITAL CONVERSION AND RECORDING SYSTEM. A. C. Lind and W. R. Plant (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 10, 1961. 32p. Contract W-31-109-Eng-52.

A rapid, versatile, automatic data recording system was developed and applied to a microdensitometer. The system measures, in 0.010 sec, any d-c voltage within its three ranges (0 to 1.000, 0 to 10.00, and 0 to 100.0 volts) and punches output numbers on standard IBM punch cards at any desired rate up to 180 four-digit numbers per minute. The system is completely automatic, self-contained, and highly accurate. Each punch card is completely filled with data, thereby minimizing the time required to put the analysis problem into the computer. (auth)

11167 (LS-87) BIBLIOGRAPHY ON LOW-NOISE AMPLIFIERS. B. Gilbert, comp. (Israel. Atomic Energy Commission, Tel-Aviv). Dec. 1960. 38p.

A bibliography covering the period January 1951 to July 1960 on low noise amplifiers is presented. 159 references. (J.R.D.)

11168 (NAA-SR-5313(Rev.)) DEVELOPMENT OF TEMPERATURE PROTECTIVE CIRCUITS FOR THE HNPF FUEL CHANNEL EXIT. D. E. Brown and C. L. Dunsmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 15, 1961. Contract AT(11-1)-GEN-8. 19p.

The HNPF plant protective system includes circuits with the function of precluding unsafe high temperature and sustained fast changes in fuel-channel coolant-exit temperatures, either in the increasing or decreasing direction. The development of the fuel-channel-exit high temperature and rate change of temperature circuits resulted in a transistorized system of plug-in components of high reliability. The circuits were designed, where possible, for fail-safe operation in case of component malfunction and for ease of maintenance and calibration. In addition to providing shutdown or scram signals, these circuits also provide setback and alarm signals. The setpoints for scram, setback, and alarm are each independently adjustable. These circuits monitor an iron-constantan thermocouple located at the outlet of a fuel cluster in the reactor. In the actual protective system, three identical circuits are used in a 2-out-of-3 coincidence arrangement to enhance the over-all reliability. (auth)

11169 (NASA-TN-D-358) THE VECTOR FIELD PROTON MAGNETOMETER FOR IGY SATELLITE GROUND STATIONS. I. R. Shapiro, J. D. Stolarik, and J. P. Heppner (National Aeronautics and Space Administration, Washington, D. C.). Oct. 1960. 14p.

The application of homogeneous-bias fields to a proton precessional magnetometer allows the measurement of the vector field by measuring the absolute scalar field F, declination variations ΔD, and inclination variations ΔI. The absolute scalar field can be measured to an accuracy of ±1 γ and absolute declination and inclination to an accuracy of ±2 min. A vector proton magnetometer, in operation at nine Minitrack stations since the spring of 1958 is described. (auth)

11170 (NASA-TN-D-485) LOW-RESOLUTION UNCHOPPED RADIOMETER FOR SATELLITES. R. A. Hanel (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Feb. 1961. 19p.

The black-body temperature and the albedo of a planet, and the variation of both parameters with latitude, longitude, and time, are of great value in understanding the climatic and meteorological conditions of the planet. An unchopped radiometer with a wide but restricted field of view is capable of such temperature and albedo measurements. Coated thermistors mounted in highly reflective cones serve as detectors. Their performance as sensor elements is analyzed in detail to prove the feasibility of the measurement. The simplicity of the instrumentation and the low information bandwidth required make the experiment equally attractive for earth satellites and space probes. (auth)

11171 (NDL-TR-2) SCATTERED RADIATION AND FREE FIELD DOSE RATES FROM DISTRIBUTED COBALT^{60} AND CESIUM^{137} SOURCES. Ralph E. Rexroad and Murray A. Schmoke (Army Chemical Corps. Nuclear Defense Lab., Army Chemical Center, Md.). Sept. 1960. 64p.

An experiment is described for checking theoretical calculations of the dose rate above uniformly distributed sources of Co^{60} and Cs^{137}. (auth)

11172 (NP-9722) NUCLEAR RADIATION RESISTANT POWER TRANSISTORS. Final Progress Report. May 15, 1959 to July 14, 1960. A. Byer (Philco Corp. Lansdale Div., Penna.). 110p. Contract DA-36-039-SC-78307.

The fabrication process for a nuclear radiation-resistant power transistor is provided in the form of a step-by-step description of each operation. A factual data section is included in which information on the fabrication process, device development, irradiation, and evaluation is given. The problems encountered and their solutions are discussed in detail. Several extra experiments were performed. These included a study of <111> oriented germanium, shock and centrifuge tests, and irradiation testing of other transistors. High-power high-frequency characteristics of transistors are included. Conclusions and recommendations, based on the experience gained from this contract, are also included. (auth)

11173 (NP-9823) AN IMAGE INTENSIFIER-SCINTILLATOR DEVICE FOR DETERMINATION OF PROFILES AND IMAGES OF WEAK BEAMS OF IONIZING PARTICLES OR QUANTA. Technical Report No. 3. Lawrence W. Jones and Martin L. Perl (Michigan. Univ., Ann Arbor. Coll. of Literature, Science, and the Arts). Jan. 1961. 17p. Contract Nonr-1224(23). (UMRI-03106-3-T).

An instrument for determining the shape and intensity distribution of particle and x-ray beams was developed using an image intensifier tube together with a bundle of filaments of scintillator. A description of the use of such a device in high-energy low-intensity secondary meson and proton beams is given. The sensitivity of this instrument represents a significant improvement over alternative techniques. (auth)

11174 (NP-9835) SUFFIELD EXPERIMENTAL STATION SHOCK TUBE INSTRUMENTATION. VI. A HIGH SPEED PNEUMATICALLY OPERATED SHUTTER. Suffield Technical Note No. 44. J. C. Muirhead and F. L. McCallum (Canada. Suffield Experimental Station, Ralston, Alberta). Oct. 31, 1960. 11p. DRB Project No. D89-16-01-09.

A shutter for use with high-speed cameras is described. It utilizes the movement of opaque diaphragms by air pressure to admit and exclude a light beam. The air pressure is controlled by established shock-tube techniques. The time required for the shutter to open and close is considerably <1 msec. It may be triggered by the event to be photographed, and its opening and closing times are independently variable by electronic means. (auth)

11175 (NYO-8643) A KAPITZA TYPE NICKEL CADMIUM BATTERY. Final Report. (Gould-National Batteries, Inc., St. Paul). Mar. 15, 1958. 9p. Contract AT (30-1)-1831.

A Kapitza type nickel-cadmium battery with the following characteristics was designed: number of plates, 10; size of plates, 35 by 35 cm; discharge time, −0.01 to 0.10 sec; life, more than 1000 cycles; and power output, −10 watts/sq cm. The cell design and materials of construction are given. (W.L.H.)

11176 (PIBMRI-879-60) COMPUTERS IN AUTOMATIC CONTROL SYSTEMS. John G. Truxal (Brooklyn. Polytechnic Inst. Microwave Research Lab.). Nov. 9, 1960. Contract AF18(603)-105. 44p. (AFOSR-TN-60-1475).

The trend from the use of simple electric circuits and elementary analog devices toward high-speed digital computers (or computers employing both digital and analog devices) is accelerated by the rapidly growing complexity of modern control systems, the development of optimizing control, and the increasing importance of self-adaptive control. Each of these three aspects is examined to delineate the class of control problems that are amendable to solution when computers are used as control elements, the requirements placed on the computer for control application, and the probable future directions of development. Examples of current uses are cited. (J.R.D.)

11177 (SC-4463(RR)) INSTRUMENTATION OF ALUMINUM BODIES TO DETERMINE INTERIOR TEMPERATURE VARIATIONS AND RATE OF SURFACE RECESSION DURING EXPOSURE TO NUCLEAR EXPLOSIONS. Period Covered March 1957−August 1957. (Detroit Controls Corp., Redwood City, Calif.). Jan. 1961. For Sandia Corp. 30p.

In order to evaluate the thermal stresses during exposure to high intensity radiation and blast effects, it is necessary to have a knowledge of the temperature distribution through the body, as well as of the position of the ablating surface with respect to the point of temperature measurement at any instant during exposure. This can best be accomplished by using embedded thermocouples and ablation indicators (defined as a device which will produce an electrical signal when an ablating surface passes a given point within a body) located at various distances from the exposed surface of the body. In addition to establishing the thermal stresses in the body, such a system should also allow evaluation of the rate of effective heat transfer to the body. Thermocouples and ablation indicators suitable for this application were developed for instrumenting ¾-in.-thick 2S-0 aluminum plates. These units were first embedded in individual aluminum plugs, which were then pressed into corresponding holes normal to the exposed surface of the plates. The performance of the embedded thermocouple and ablation indicator designs was determined in the laboratory by measuring the output of a number of models during actual melt tests in a high-velocity oxyacetylene flame. Nine plates so instrumented were used in actual nuclear tests. (auth)

11178 (SC-4530(RR)) INTERIM REPORT ON DEVELOPMENT OF DESIGN CRITERIA FOR RELAYS, COVERING PERIOD SEPTEMBER 1 TO OCTOBER 31, 1960. (Oklahoma State Univ., Stillwater. School of Electrical Engineering). Dec. 1960. 61p. For Sandia Corp., Albuquerque, N. Mex.

Progress is reported in the design of control and signal type sealed military relays. Results are included from an examination of relay actuator efficiency, examination of the validity of the transit time expression derived in previous work, a review of the different expressions developed in analyzing the relay, and the development of a logical procedure by which it can be determined if a relay can be built to meet a given set of specifications. (C.H.)

11179 (TID-11346) ADVANCED TECHNIQUES FOR EXPERIMENTAL STRESS ANALYSIS. (Extension of the Imbedded Gage Technique). Robert I. Brasier (New Mexico. Univ., Albuquerque). 1960. 20p. [For Sandia Corp.] (SCDC-2139X)

In applications of the imbedded gage technique, care must be taken to ensure that the inclusion of the gage does not influence the strain, or strain distribution, in the model under test. The presence of gage effects may be photoelastically in models made from optically clear, double-refracting materials. However, if a compensator is not used, the photoelastic method is limited in accuracy to $\sim \frac{1}{2}$ fringe order. Commercial gages were investigated to see if their measured gage factor could be correlated with any observed reinforcing effect noted photoelastically. (W.L.H.)

11180 (UCRL-9464) A NEW SATURABLE TRANSFORMER MEASURES DIRECT CURRENT THROUGH CONDUCTORS IN THE VICINITY OF LARGE STRAY MAGNETIC FIELDS. Alfred Windsor (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 17, 1960. Contract W-7405-eng-48. 15p.

An improved d-c transformer is described which operates without its accuracy being impaired by stray magnetic fields because the ampere-turn balance is continuous. Applications are especially useful in physics research. (auth)

11181 (USNRDL-TR-464) MEASUREMENT ERROR FROM ENERGY DEPENDENCE OF UNSATURATED CURRENT IONIZATION CHAMBERS. A. H. Redmond (Naval Radiological Defense Lab., San Francisco). Sept. 30, 1960. 17p.

The consequences of a nonconstant response of an ionization chamber to equal intensities of γ photons of different energies are discussed. No rate sensitivity arose from energy sensitivity with an unsaturated chamber having a parabolic response or with a linear chamber. A rate sensitivity was observed in an unsaturated chamber with logarithmic response. The rate sensitivity resulted from an energy sensitivity to monochromatic photons at low intensities, but it progressively decreased at higher intensities. (C.J.G.)

11182 (USNRDL-TR-467) A COMPACT TWO-STAGE GAS CHROMATOGRAPH FOR FLASH PYROLYSIS STUDIES. S. B. Martin and R. W. Ramstad (Naval Radiological Defense Lab., San Francisco). Oct. 7, 1960. 18p. (DASA-1186)

A compact, portable, two-stage gas chromatography system that permits the direct measurement of the complex reaction products of flash pyrolyses was constructed and operated as part of a program dealing with the high-temper-

ture behavior of materials. A unique feature of this system is that the flash pyrolysis reaction is carried out directly in the carrier gas stream just prior to its entering the first of two initially coupled stages. Products of the reaction mixed with the helium carrier go directly onto a gas-liquid partition column (GLPC). The fixed gases, unresolved by the GLPC stage, are eluted together and pass onto a gas-solid adsorption column (GSAC). The two stages are then uncoupled, diverting the output of the GLPC stage from the GSAC input to preclude the irreversible adsorption of substances subsequently eluted by the GLPC stage. The GSAC stage concurrently analyzes the fixed gases using a carrier stream of virgin helium. To achieve the pressure balance necessary to perform such a valving operation, a unique flow control was developed which provides an adjustable flow resistance to match that of any of the columns used in the flow ranges of 50 ml/min and up. To secure maximum component density, the columns (two in each stage) are wound around a cylindrical brass block containing the tungsten-filament detectors. The block and its columns, along with a thermostated heating element, fit in a 3- by 7-in Dewar flask. The entire system, exclusive of helium supply and detector voltage supply, is contained in a portable 20- by 20- by 12½-in. cabinet. Details of construction, performance, and utility of the instrument are described. (auth)

11183 (USNRDL-TR-488) A WRIST-CARRIED HIGH RANGE GAMMA-DETECTING RATEMETER. R. L. Hopton (Naval Radiological Defense Lab., San Francisco). Dec. 15, 1960. 24p.

The blocking oscillator was combined with a selected cadmium sulfide γ radiation-sensitive crystal to produce a recycling ratemeter that can be carried on the wrist. This instrument features hermetic construction, rechargeable nickel-cadmium battery, range switching (0-5, 50, 500 r/hr), low-current drain, and small number of parts. Included are a mathematical analysis of the voltage variable capacitor trigger circuit and a description of the magnetically actuated range switch mechanism which permits true hermetic operation. Calibration is maintained within ±15% for all combinations of temperature (-40 to +50°C), humidity (0 to 100%) and battery condition (1.15 to 1.35 volts). (auth)

11184 (USNRDL-TR-491) SUMMARY OF THE INVESTIGATION OF THE RESPONSE OF CADMIUM SULFIDE. L. D. Miller and A. J. Jaske (Naval Radiological Defense Lab., San Francisco). Dec. 19, 1960. 50p.

Work in the development of a photoconducting cadmium sulfide crystal to be used as a γ-radiation detector is summarized. The specifications for such a detector are given. Experimental data on the crystal's response to γ radiation and incident visible and near visible light are presented, and there is a discussion of the various techniques involved in growing and preparing the crystals for use. Also included is a presentation of the different types of measurements used to determine crystal structure and properties. (auth)

11185 (WADC-TR-59-508) STUDIES TOWARD AN IMPROVED RADIOACTIVE IONIZATION GAGE FOR MEASUREMENT OF EXTREME ALTITUDE AND VELOCITIES. J. G. Ballinger and R. C. Horn (Minnesota. Univ., Minneapolis). June 30, 1959. Contract AF33(616)-3569. 113p. (AD-240932)

The continued development of a radioactive ionization pressure gage head and associated readout circuit for the measurement of pitot and static pressures encountered in flight over an altitude range from 0 to 300,000 ft and Mach number range from 0 to 7 is described. A preliminary circuit of a pulse type readout was developed which was capable of measuring the ionization current output from the gage head over a range of five decades without switching. A wind tunnel program was conducted to determine static pressure port locations on the X-15 aircraft which are independent of angle of attack at M = 6.8. The results are presented in graphical form, and suitable locations are recommended. Analytical studies were made to determine the time response of various gage volume and connecting tubing combinations, such as would be used in aircraft applications. The effects of thermal transpiration were also investigated. (auth)

11186 (WADD-TR-60-471) ELECTRON PHYSICS OF TRAVELING WAVE TUBE DEVICES. J. R. Whinnery, D. H. Sloan, C. Susskind, C. K. Birdsall, Y. Aoki, T. E. Everhart, A. W. Trivelpiece, and R. Mueller (California. Univ., Berkeley). July 1960. Contract AF33(616)-6139. 54p.

The work described includes theoretical and experimental studies on cold-cathode crossed-field devices, electron beams, fast-wave interaction with electron streams, solid-state and electron-beam parametric amplifiers, backward-wave interaction with waves on a ferrite rod or in plasmas, large-signal effects in traveling-wave tubes, and novel fast space-charge wave devices. (auth)

11187 (AEC-tr-4414) LIQUID SCINTILLATORS FOR RADIOCARBON DATING IN ARCHAEOLOGY. I. E. Starik, S. I. Rudenko, V. V. Artem'ev, S. V. Butoma, V. M. Drozhzhin, and E. N. Romanova. Translated from Report No. RICC/317 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 10p.

Scintillation counters were used for measuring the activity of natural carbon in archeological specimens. The carbon for investigation is added in the form of a solvent or diluent of the liquid scintillator. Benzene and ethylbenzene proved to be good solvents for this purpose. This method permits the determination of C^{14} in older samples and increases the accuracy of the determination. Results are included of age measurements on a variety of archeological specimens. (C.H.)

11188 (AEC-tr-4444) COUNTING OF RADIOISOTOPES OF METALLIC ELEMENTS IN LIQUID SCINTILLATORS. Gerhard Erdtmann and Günter Herrmann. Translated by Lydia Venters (Argonne National Lab.) from Z. Elektrochem., 64: 1092(1960). 14p.

To transfer the radioisotopes of metallic elements to liquid scintillators, the following possibilities were investigated: (1) Mixing of the aqueous solution with a dioxane-containing liquid scintillator to a homogeneous system; (2) Production of a stoichiometric compound soluble in toluene, as for instance, of a metal salt in a fatty acid; (3) Extraction in toluene by excess of an extracting agent, and (4) Emulsification of the aqueous solution with a liquid scintillator. For small volumes (to about 1 ml) of the aqueous solution the fourth method is the most effective; the highly dispersed silicon dioxide is used as thixotropic reagent. Larger volumes of the solutions may be processed the best according to the third method. Of all the extracting agents investigated, tri-, di-, and mono-n-butyl phosphate, di-(2-ethylhexyl)-phosphate, tri-n-octyl phosphinoxide, and tri-iso-octylamine are usable, whereas 8-oxyquinolin, acetylacetone, and thenoyl-trifluoroacetone display too high quenching. The second method is cumbersome, and in the first method the volumes of the aqueous solution due to quenching and disintegration, especially in acid solutions, are limited to 0.2 to 0.5 ml. (auth)

11189 (CEA-tr-A-825) FORME DES RAIES D'UN RAYONNEMENT γ MONOCHROMATIQUE DANS LE SPECTROGRAPHE A SCINTILLATIONS. (The Shape of Lines of Monochromatic γ Radiation in the Scintillation Spectrograph). D. Maeder, R. Muller, and V. Wintersteiger. Translated into French from Helv. Phys. Acta, 27: No. 7, 3-44(1954). 64p.

The analysis of complex spectra with a scintillation spectrograph requires the knowledge of the intensity and form of the spectra for each γ energy. These factors are dependent in a complex manner not only on the energy but on the size and shape of the crystal and on the geometry of the γ beam. Therefore a systematic study was made of the energy regions from 0.1 to 1.3 Mev. First, a survey was made of the methods of calculation used, and the theoretical formulas and numerical constants used for the primary effect in NaI are given. The absorption of secondary and tertiary scattering quanta is calculated in the case of a crystal with infinite dimensions. A study is then made of the secondary effect in a finite crystal. The space angle of a collimator and the correction caused by an imperfect collimation of the secondary effect calculated in the crystal are then considered. Various small corrections to the radiation are then illustrated. The experimental shape of the lines was studied with monochromatic γ radiation of 0.28 to 1.1 Mev with a pulse spectrograph. A good correlation is obtained between the experimental results and the calculated pulse distribution. (J.S.R.)

11190 (CEA-tr-R-1053) RECHERCHES SUR LES MATIERES ORGANIQUES POUR SCINTILLATEURS. II. SYNTHESE DES DERIVES 2-ARYL DU 1,3,4,-OXADIAZOL. (Research on Organic Materials for Scintillators. II. Synthesis of 2-Aryl-1,3,4-Oxadiazole Derivatives). A. N. Grekov, O. N. Shvaika, and L. M. Egupova. Translated into French from Zhur. Obshchei Khim., 29: 2027-31(1959). 11p.

Eight 2-aryl derivatives of 1,3,4-oxadiazole, not previously described in the literature, were synthesized, and their properties were studied. The production conditions for the intermediary products are also defined. Procedures for the synthesis of amine derivatives of 1,3,4-oxadiazole were perfected. (tr-auth)

11191 (CEA-tr-R-1085) DEVELOPPEMENT ISOTHERMIQUE DES COUCHES DES CHAMBRES D'EMULSIONS. (Isothermal Development of Layers of Emulsion Stacks). D. M. Samoilovich and E. S. Barinova. Translated into French from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 4: 383-4(1959). 5p.

The possibility of uniformly developing NIKFI layers of the "P" type was investigated. The tests were made at 5, 8, 10, 12, and 15°C at a pH between 6.5 and 7.2, varied at intervals of 0.1. The development time was from 1 to 8 hr. The isothermal method was used. The results, which are tabulated, showed that the development temperature should not exceed 10°C, with a development time not over 4 hr. The optimum conditions are a development time from 2.5 to 4 hr, developer pH between 6.7 and 7.0, and a temperature from 8 to 10°C. Tests were made on supported and unsupported emulsions. (J.S.R.)

11192 (CEA-tr-R-1101) ACCROISSEMENT DE LA SENSIBILITE DE L'EMULSION DE TYPE "R." (Increasing the Sensitivity of "R" Type Emulsions). D. M. Samoilovich, M. I. Belogorodskiĭ, and E. S. Barinova. Translated into French from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 3: 284(1958). 4p.

In the treatment of photographic layers of the "R" type with solutions of triethanolamine, an increase in the sensitivity and in the blackening is observed. The introduction of triethanolamine into high-sensitivity nuclear emulsions causes a faster increase in the blackening than in the sensitivity. The hypothesis was made that the action mechanism of the triethanolamine consists in an elevation of the pH of the emulsion and of its reducing effect on the crystals of the silver halides. This hypothesis was verified. (J.S.R.)

11193 (CEA-tr-R-1103) SPECTROMÈTRE À SCINTILLATIONS POUR LES NEUTRONS RAPIDES. (Scintillation Spectrometer for Fast Neutrons). Yu. (Iu.) A. Egorov. Translated into French by B. Rosenbaum from Pribory i Tekh. Ekspt., No. 3, 21-6(1958). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 1318.

11194 (CEA-tr-R-1157) SCINTILLATEURS DE GRAND VOLUME EN MATIERE PLASTIQUE. (Plastic Scintillators of Large Volume.) M. N. (M. I.) Medvedev, E. N. Matveeva (Matveev), and L. Ya. Zhil'tsova (L. Ia. Jiltsov). Translated into French from Pribory i Tekh. Ekspt., No. 3, 45-8(1958). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 1323.

11195 (DEG-Inf.-Ser.-142) THREE PHASE SHUNT WOUND ELECTRIC MOTORS FOR DRIVING CENTRIFUGES. G. Lammeraner. Translated by H. W. Curtis from Elektrotech. u. Maschinenbau, 54: 378-81(1936). 7p.

Comparison between the Schrage motor and the normal induction motor shows that the drive of large high-speed centrifuges by Schrage motors has considerable advantages. (auth)

11196 (JPRS-7492) AN ACOUSTICAL ANEMOMETER. V. M. Bovsheverov and V. P. Voronov. Translated from Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz. No. 6: 882-5 (June 1960). 15p.

Design and development of an accoustical anemometer are outlined. The instrument is designed for investigating turbulence in the ground layer of the atmosphere. The parameters of the instrument include single-valued scales at 6.5 to 26 m/sec, maximum sensitivity 5 and 20 m/sec per division, and absolute stability ~2.5 and 10 cm/sec. The response characteristic of the instrument is 3 m/sec. (J.R.D.)

11197 (NASA-TT-F-54) CONCERNING A METHOD FOR THE MEASUREMENT OF VERY HIGH TEMPERATURES IN NEARLY TRANSPARENT ARC COLUMNS. Rudolf Wilhelm Larenz. Translated from Z. Physik, 129: 327-42(1951). 20p.

A method of measuring the temperature distribution across an arc column by use of a spectrograph is described. An equation is developed for the determination of the electronic temperature that corresponds to the point of maximum spectral line intensity across such a column. A graphic solution is given which relates the various parameters such as statistical weights, excitation potential, and pressure to spectral line intensity and temperature. (auth)

11198 (NP-tr-558) SPECTRORECORDER OF RADIATION VELOCITIES. G. A. Monin. Translated from Izvest. Krym. Astrofiz. Observatorii No. 8: 119-22(1952). 3p.

The recorder is an essential supplement to the spectroheliograph which provides for photographic display of radiation velocity distribution from solar elements. A recorder of this type is in use in the solar unit of the Simeiz Observatory. (J.R.D.)

11199 (NP-tr-560) INFRARED RAYS IN WARFARE. V. E. (Ye.) Kichka. A Translation from Pages 59-73 of Infrakrasnye Luchi V Voyennom Dele, Moscow, 1958. 14p.

The design and construction of instruments used in warfare that use infrared rays are described. Included are an optical blocking system consisting of a transmitter, receiver, and signal device; an optical telephone for the transmission of speech or telegraph signals by means of infrared-sensitive photocells used as signal receivers; a thermal heat detector for the detection of targets emitting thermal radiation, such as ships, aircraft, and tanks; a bolometer-radiant-energy indicator for use in the search for targets having comparatively low angular velocity of motion; a thermo-DF photovaristor for use in locating targets; photoelectric fuzes for missiles which cause the shell to detonate only when close to the target. Instruments of this type can be used in the search for enemy infrared projectors and consequently also for the detection of night vision instruments, and for the reception of signals transmitted by infrared projectors for coded infrared communication. These instruments are simple and have small weight and dimensions. Deficiencies include low sensitivity and the impossibility of identifying the detected radiation targets. (C.H.)

11200 (SCL-T-346) RESPONSE CURVES OF ELECTROMAGNETIC SEISMOGRAPH (1). Tokuji Utsu. Translated by Noburu Hiraga from Kenshin Jihô, 22: No. 4, 5-18 (July 1957). [nd]. 19p.

A mathematical analysis is presented of an electromagnetic seismograph. (W.L.H.)

11201 (SCL-T-348) THE CHARACTERISTICS OF ELECTROMAGNETIC SEISMOGRAPHS. Gaston Grenet. Translated by A. A. Horvath (Sandia Corp., Albuquerque, N. Mex.) from Ann géophys., 8: 328-32(1952). 11p.

On the basis of the known results, it is shown how it is possible to determine all the characteristics obtainable by means of a seismograph composed of a pendulum and a galvanometer, with only two families of curves. Subsequently the known results are partially generalized to allow a brief study of the case where use is made of several galvanometers of two windings, arranged in a series, with only the last one used for registration. (auth)

11202 (UCRL-Trans-457) NIKFI PHOTO MATERIALS FOR NUCLEAR STUDIES OF TYPES A-2, Ya-2, AND K. K. S. Bogonolov, A. A. Sirotinskaya, M. Yu. Deberdeev, and V. M. Urarova. Translated by Richard B. Mudge from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst., 11: (21), 58-65(1957). 22p.

The development, production, properties, and uses of NIKFI A-2, Ya-2, and K photoemulsions are discussed. The A-2 plates are for radioprospecting, the Ya-2 plates record proton tracks up to 40 or 50 Mev, and the K type plates record proton tracks up to 150 or 200 Mev. Processing details are also given. (T.R.H.)

11203 (UCRL-Trans-458) PHOTOPLATES OF TYPES T-1, T-2, AND T-3 FOR DISCRIMINATING TRACES OF SINGLY-CHARGED PARTICLES AND ALPHA-PARTICLES. A. A. Sirotinskaya (Sirotinskaia) and K. A. Bogomolov. Translated by Richard B. Mudge from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst., 11: (21), 66-72(1957). 16p.

A comparative study was made of methods for increasing the discriminating capacity of photoplates. The methods investigated may be classified as emulsion-preparation, latent image formation, and special development. Three types of photoplates for singly charged particles and α particles are described: T-1 for α tracks in strong neutron beams; T-2, for lithium filling for study of neutron reactions; and T-3, for recording protons up to 25 Mev with discrimination of the ends of p and α tracks with reduced γ background. (T.R.H.)

11204 (UCRL-Trans-604) A TENSION METER FOR DETERMINING RELATIVE IONIZATION IN A PHOTOEMULSION. Ya. P. Malkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. and Tbilisskii Gosudarstvennyi Universitet im. I. V. Stalina, U.S.S.R.). Translated by Richard B. Mudge from report JINR-P-351. 12p.

An apparatus used as an attachment to a microscope which facilitates measurement of particle tracks in emulsions is described. The length and number of track discontinuities can be determined by use of the attachment, and these data can in turn be used in estimating the relative ionization which occurred in the photoemulsion. (J.R.D.)

11205 ON THE SIMULTANEOUS DISTRIBUTION OF THE SAGITTAS OF A TRACK IN EMULSION IN THE CASE OF BACK GROUND NOISE. L. Jánossy (Central Research Inst. of Physics, Budapest, Hungary). Acta. Phys. Acad. Sci. Hung., 12: 139-50(1960). (In English)

A simple method is given for evaluating the simultaneous distribution function of sagittas of a track in emulsion in the case of coulomb scattering only and also when background noise is present. The expression thus obtained will be made use of in a subsequent paper for the maximum likelihood determination of the scattering parameters of such a track. (auth)

11206 FADING OF TRACKS OF ALPHA PARTICLES IN NUCLEAR EMULSIONS AND A METHOD FOR THE CORRECTION OF THE VISIBILITY OF ALPHA PARTICLE TRACKS IN THE GAMMA BACKGROUND. Z. Lewandowski, M. Makowska-Rzeszutko, and Z. Wróbel (Inst. of Nuclear Physics, Krakow and Jagellonian Univ., Krakow). Acta Phys. Polon., 19: 599-603(1960). (In English)

Latent images of tracks of α particles and γ radiation were removed in Agfa-K2 and NIKFI-K emulsions 100 μ thick by using the vapor of hydrogen peroxide at different concentrations as an oxidizing agent at 28 and 32°C. A method is also proposed for increasing the visibility of heavy particle tracks in the presence of a γ background. The method is based on the brief exposure of the exposed plate to vapor of a 6% hydrogen peroxide solution before development. (J.S.R.)

11207 FAST-NEUTRON SCINTILLATION LAYER-DETECTOR FOR MEASUREMENTS AGAINST γ-RAY BACKGROUND. W. S. Yeffseyev, W. J. Komarov, W. Kusch, W. S. Roganov, W. A. Tchernogorova, and M. Szymczak (Joint Inst. for Nuclear Studies, Dubna, USSR). Acta Phys. Polon., 19: 675-82(1960). (In English)

A scintillation layer-detector with high detection efficiency for fast neutrons and low efficiency for γ rays is described. The detector is designed for the neutron measurements in the 5 to 20 Mev energy range. Its operation is based on the difference in range between protons and electrons of the same energy. (auth)

11208 DIFFUSION CLOUD CHAMBER WITH A VACUUM JACKET. Anthony A. Silvidi and Donald Marn (Kent State Univ., Ohio). Am. J. Phys., 29: 99-101(Feb. 1961).

A diffusion cloud chamber with a vacuum jacket was experimentally tested for its effectiveness in increasing the sensitive area of the chamber. Evidence is presented which indicates that such a jacket can increase the effective area for observing tracks. (auth)

11209 CONSTRUCTION AND DESIGN OF A 4π GAS FLOW COUNTER. E. Rodriguez Mayquez, A. Morales

Villasevil, and R. Nunez-Lagos (Junta de Energia Nuclear, Madrid). Anales real soc. espan. fis. y quim. (Madrid), Ser. A, 56: 207-11(July-Aug. 1960). (In Spanish)

The design and set up of a 4π gas flow counter are described. A mixture of argon (96%) and CO_2 (4%) was used as filling gas. Plateaus, approximately 150 volts wide, were obtained showing a slope clearly lower than 1% in 100 volts. (auth)

11210 CHARACTERISTIC FEATURES OF ELECTRONIC DEVICES EMPLOYED IN THE STUDY OF NUCLEAR RADIATION. Agustin Tanarro Sanz. Anales real soc. espan. fis. y quim. (Madrid), Ser. A, 56: 212-23(July-Aug. 1960). (In Spanish)

The most characteristic features of the electronic devices employed in nuclear physics measurements are pointed out. The way in which these devices have continuously increased in complexity, assimilating techniques developed in other electronic fields, mainly in that of digital computers, is discussed. (auth)

11211 THERMOLUMINESCENCE AND DOSIMETRY OF SAMARIUM-ACTIVATED CALCIUM SULFATE. H. Peter (Universität, Giessen, Ger.). Atomkernenergie, 5: 453-5(Dec. 1960). (In German)

The phosphorescent substance $CaSO_4$ (Sm) was tested as to its suitability for a thermoluminescent dosimeter. The dependence of the thermoluminescence on the conditions of manufacture (tempering, effect of the activators, and glowing atmosphere) was investigated. The phosphorescent substance shows a good proportionality between the dose and total light intensity with 0.005 to 3000 r. The energy storage is quite satisfactory. (auth)

11212 PULSE PILE-UP IN SCINTILLATION SPECTROMETRY WITH HIGH PULSE DENSITY. G. Brunner (Institut für Angewandte Radioaktivität, Leipzig). Atomkernenergie, 5: 456-8(Dec. 1960). (In German)

Simple considerations on shape and statistics of pulses may explain weak maxima in scintillation spectrographs at twofold energy of real emission lines or at the sum of energies of two lines of the concerning radioactive sources as pile-up of pulses. The effects of pulse rates, collecting time, and decay time of pulses may be determined easily with a formula which is experimentally confirmed. From variation of the pile-up abundance with temperature can be followed an increase of decay time of pulses from NaI(Tl) with increasing temperature. There is a factor of about 2 for an interval of 60°C near 0°C. (auth)

11213 AEROSOLS AS CARRIER OF NATURAL RADIOACTIVITY. K. Stierstadt and M. Papp (Universität, Munich). Atomkernenergie, 5: 459-61(Dec. 1960). (In German)

An apparatus for ionization and mobility separation of naturally occurring aerosols was constructed. The natural β activity of the particles was used as an indicator. A distribution of 65% of the activity on particles with radii between 1 and 13×10^{-7} cm resulted. No essential preference of a distinct particle size was found in this region. The results were compared with similar measurements of Wilkening in New Mexico. (auth)

11214 A PORTABLE DOSE-RATE METER. H. Niedrig and K. Tradowsky (Technische Universität, Berlin). Atompraxis, 6: 480-2(Dec. 1960). (In German)

The article describes a device for measuring the dose rate of gamma rays and demonstrating beta rays. The device, which is used for radiation monitoring, is fully transistorized and has a NaI crystal with photomultiplier as a radiation indicator. The measurement range extends from 1 μr/hr to 1 r/hr, with an approximately logarithmic reading. A simple switch device prevents the indicator needle from moving back, even with high-dose outputs (>1r/hr). (auth)

11215 RADIATION MONITORING WITH THE FILM METHOD IN RADIUM AND ISOTOPE LABORATORIES. H. Heinemann and K. H. Seidler (Firma Buchler & Co., Brunswick). Atompraxis, 6: 483-4(Dec. 1960). (In German)

The conclusions reached in the reply to this article [Atompraxis, 6: 10-11(1960)] are rejected. The irradiation of the film badges was carried out with standard sources, the output of which had been measured by the PTB (Physikalisch-Technische Bundesanstalt, Braunschweig) or by the Atomic Energy Research Establishment in Harwell. Discrepancies between applied doses and evaluation results can be basically attributed neither to poorly defined radiators nor to delays in the use or evaluation of the badges. The authors point out once again the faulty determination of gamma radiation, which manifests itself particularly in radiation mixtures with soft components. An improvement in the film method is considered absolutely necessary before it can be used in radium and isotope laboratories. (auth)

11216 THEORETICAL STUDY OF THE CURVES OBTAINED FROM A MONOCANAL γ SPECTROGRAPH. Jean Claude Philippot. Bull. inform. sci. et tech. (Paris), No. 45, 2-12(Nov. 1960). (In French)

A single-channel γ spectrograph that includes a single-channel selector and an integrator was used to plot the spectrum of a γ emitter. A study was made to estimate and correct the systematic deformations introduced into the spectrum by these devices. When the extent of the deformations was determined, it was possible to study two different radioactive elements so that the spectra obtained could be directly compared. (auth)

11217 SCINTILLATION α-SPECTROMETER. H. L. Zaborowski. Bull. inform. sci. et tech. (Paris), No. 45, 13-22(Nov. 1960). (In French)

An α spectrometer operated by pressure variation and using a hemispherical ZnS (Ag) phosphor is described. This apparatus is a modern version of the visual scintillation counter. Its usefulness is stressed for experiments and laboratory uses. (auth)

11218 DISCRIMINATION OF SHAPES WITH A MINERAL SCINTILLATOR (CsI). APPLICATION TO THE TRACING OF α SPECTRA OR OF PROTON SPECTRA IN THE PRESENCE OF γ RAYS. Francis Cambou, Jean-Pierre Crettez, and Georges Ambrosino. Compt. rend., 251: 2681-3(Dec. 5, 1960). (In French)

The shape of the scintillation produced by ionizing particles in cesium iodide is different for protons, α particles, and electrons. A circuit extracting part of this difference permits the suppression of the γ background when the spectrum of α particles or protons is measured. The spectrum of recoil protons from 3-Mev neutrons is shown. (tr-auth)

11219 DESCRIPTION OF NIP JUNCTIONS UTILIZED AS DETECTORS OF NUCLEAR PARTICLES. SPECTROMETRY OF HIGH ENERGY IONIZING PARTICLES. DETECTION OF γ RAYS. Lydie Koch, Jean Messier, and Jean Valin. Compt. rend., 251: 2912-14(Dec. 19, 1960). (In French)

The properties of silicon NIP junctions permit the utilization range of semiconductor radiation detectors to be extended to high energies. In a first stage it was possible to measure the energy of 40-Mev α particles with an energy resolution of 2%. With these junctions γ rays were detected, and a photoelectric peak was found. (tr-auth)

11220 ELECTRONICS FOR HANDLING RANDOM EVENTS. D. G. Maeder (European Organization for Nuclear Research, Geneva). Energia nucleare (Milan), 8: 16-28(Jan. 1961). (In English)

The randomness of pulses produced by nuclear detectors and the problems faced in electronics for handling such pulses are taken into consideration. The problems of analyzing the random time distribution and the random pulse-height distribution are examined. The outstanding aspects of instruments and electronics circuits needed to analyze such pulses, i.e., (1) oscilloscopes, short-time-interval measuring circuits, triggers, and counters (for time measurements) and (2) linear amplifiers, pulse-height analyzers, and storage techniques (for pulse-height measurements), are reviewed. (auth)

11221 ON THE ESTIMATION OF LOSSES DURING PROCESS OF FORMING LATENT PHOTOGRAPHIC IMAGE BY IONIZING PARTICLES. A. L. Kartuzhanskii (Inst. of Soviet Commerce, Leningrad). Fiz. Tverdogo Tela, Akad. Nauk S.S.S.R., Sbornik Statei, 2: 296-300(1959). (In Russian)

An attempt is made to develop equations for evaluating image losses in emulsions as a function of particle charge, mass, and energy. The obtained data for 10-Mev protons, 40-kev electrons, and relativistic singly charged particles are tabulated. (R.V.J.)

11222 FIRST MEASUREMENTS WITH A NEW TYPE HIGH RESOLUTION SPECTROMETER. O. Huber, L. Schellenberg, and H. Wild (Inst. of Phys., Freiburg). Helv. Phys. Acta, 33: 534-40(1960). (In German)

The construction of a spectrometer with the field configuration $H = H_0(1 - \alpha e + \beta e^2 - \gamma e^3)$ for $\alpha = 1/2$, $\beta = 3/8$, and $\gamma = 43/144$ and the ability to take measurements with film and to record energy range simultaneously is described. The field configuration was independent of the hysteresis of the iron, and the pole distance could be made very large in comparison to the magnet diameters. The first calibration measurements, which were made to determine the behavior of the iron, the controllability of the field, the focusing properties, and the resolution are reported. (J.S.R.)

11223 SOME RESULTS ON BUBBLE FORMATION BY THE α DECAY OF Po^{210} AND BY FAST ELECTRONS. G. Riepe and B. Hahn (Physikalisches Institut der Universität, Freiburg). Helv. Phys. Acta, 33: 540-43(1960). (In German)

In the study of bubble formation in a bubble chamber, a knowledge of the experimental relation among bubble density, pressure difference Δp (degree of superheating), and temperature is required. The surface tension and the heat of evaporation must also be known. These relations were determined for the α particles from Po^{210} in CCl_2F_2 and for fast electrons (31 Mev) in $CBrF_3$ and SF_6. A cloud chamber with pressure stabilization, which made possible a constant Δp value for 50 to 150 msec, was used. The results show that at constant temperature bubbles are formed only when Δp exceeds a critical value. The pressure difference necessary for bubble formation decreases with increasing temperature. The bubble density at various temperatures was determined for electrons as a function of the pressure difference. (J.S.R.)

11224 p-n JUNCTIONS AS SOLID BODY IONIZATION CHAMBERS. E. Baldinger, W. Czaja, and A. Z. Farooqi (Universität, Basel, Switzerland). Helv. Phys. Acta, 33: 551-7(1960). (In German)

An analogy was drawn between a gas ionization chamber and a solid-body ionization chamber to determine if an accurate knowledge of the applicability of semiconductors as ionization chambers could be obtained. The magnitude of the charge collected as a function of the bias voltage U applied to the diode is influenced by the variation of the junction capacity with U, the variation of the recombination loss with U, and the variation of the track length in the "active volume" as a result of the broadening of the space charge zone with U. For a clarification of these effects a silicon p-s-n diode was used as a detector for polonium α radiation. The results showed that the diode capacity varied approximately as $U^{-\frac{1}{2}}$. It was experimentally shown that the principal influence in the "saturation phenomenon" observed can be traced back to the variation of the diode capacity with the voltage U. The recombination loss is small, and the track length varies only slightly in the counter volume. Corresponding results were obtained for Au-Ge diodes. (J.S.R.)

11225 DETERMINATION OF THE ENERGY RANGE SPECTRUM OF WEAKLY ACTIVE α PREPARATIONS. P. Huber and F. Widder (Physikalische Anstalt der Universität, Basel, Switzerland). Helv. Phys. Acta, 33: 567-70 (1960). (In German)

The problem of measuring the α activity of the residues from the evaporation of weakly radioactive precipitation and industrial wastes led to the construction of an apparatus for this measurement. The construction of the apparatus is shown schematically. The substance to be investigated forms a thin layer on the interior of a hollow sphere. The α particles are counted with a thin ZnS layer and a photomultiplier. The multiplier is so placed that the mid point of the scintillation layer coincides with the mid point of the sphere. The complete structure is placed within a tight housing in which the pressure can be varied from 0 to 2 atm. The advantages of this geometry are tabulated, and examples of measurement results are shown. (J.S.R.)

11226 CALIBRATION OF NOBLE METAL THERMOCOUPLES AT THE MELTING POINT OF PALLADIUM. B. K. Bragin. Izmeritel'naya Tekh., No. 12, 15-18(Dec. 1960). (In Russian)

The calibration error of platinum-rhodium thermocouples above 1200°C can be decreased by an additional determination of the thermal emf of the working junction at the melting point of palladium (1552°C ± 2°C). A piece of pure palladium wire (99.95% Pd) with a diameter of 0.4 mm and a length of 15 to 20 mm was wrapped around the junction to be calibrated and immersed in a furnace held at a temperature of 10 to 15°C above the melting point of palladium by means of a control thermocouple. Constant readings of the thermal emf were observed on a compensated, low-resistance potentiometer with a subsequent sharp increase in temperature after the fusion of palladium was complete. The agreement with the results obtained with a standard optical pyrometer is good. (TTT)

11227 PRECISION OF X-RAY FOCUSING BY BENT CRYSTALS. P. A. Berzirganyan (Erivan State Univ.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk 13, No. 4, 59-64(1960). (In Russian)

It is shown that in all cases of horizontal x-ray focusing by bent crystals the width of the spectral lines depends on the length and thickness of the crystal. (R.V.J.)

11228 EFFECT OF SOLUTE CONCENTRATION ON THE RADIATION YIELD OF FERROUS IONS OXIDATION AT HIGH DOSE RATES. A. K. Pikaev and P. Ya. Glazunov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 11, 2063-4(Nov. 1960). (In Russian)

It was found previously that at low radiation levels and within the concentration range of 10^{-4} to 10^{-2} M/l, the oxi-

dation yield of Fe^{2+} does not depend on the initial concentration of the solution. This question was further investigated at higher levels, using solutions containing Mohr's salt ($FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$) and small amounts of NaCl, exposed to 0.8 to 0.9 Mev electron fluxes. The Fe^{3+} formed was determined spectrophotometrically. The autooxidation of Fe^{2+} at concentrations higher than 10^{-2} M was taken into consideration. The energy absorbed by the solution was found to be much smaller than needed for the complete oxidation of the bivalent iron and for the consumption of the oxygen in the solution. At a flux of about 10^{21} ev/ml/sec the yield does not depend on the initial concentration within the range of 3×10^{-3} to 10^{-2} M and at 3.5×10^{22} ev/ml/sec within the range of 10^{-3} to 10^{-2} M. At very low Fe^{2+} concentrations the Fe^{3+} yield is much reduced. Thus increase of the flux level leads to a narrowing of the concentration range within which the yield is independent of the initial concentration. At low concentrations the reaction $HO_2 + HO_2 \rightarrow H_2O_2 + O_2$ plays a greater role in reducing the Fe^{3+} yield. (TTT)

11229 PERFORMANCE OF IONIZATION α SPECTROMETERS WITH HEAVY LOAD. A. A. Vorob'ev and V. A. Korolev (Inst. of Physics and Technology, the Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1086-91(Sept. 1960). (In Russian)

A method is suggested for increasing the α spectrometer performance load up to 10^4 pulses/sec. The performance of the heavy-load spectrometer was verified by measuring the α spectrum from a Pu^{238} source with intensity of 8×10^3 pulses/sec and the spectrum of generated pulses delivered to the amplifier simultaneously with the α-particle pulses. The spectrometer can be utilized for recording low-intensity α transitions, in measuring α-γ angular correlations, and as coincidence spectrometer with β spectrometer. (R.V.J.)

11230 DOUBLE-FOCUSING MAGNETIC SPECTROMETER. I. G. Afanas'ev (Khar'kov Inst. of Physics and Technology, the Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1157-64(Sept. 1960). (In Russian)

A method is described for developing an ideal horizontal focusing with an improved vertical focusing. The method includes also the consideration for the expansion of scattering field. Magnetic screens are installed at the entrance and exit of the beam in order to reduce the expansion of the field scattering and for more accurate determination of the field. The formulas for calculating the horizontal and vertical focusing, considering scattered field, are included. The principle scheme of the spectrometer is shown. The results of the tests made with one of the spectrometers showed excellent results. Further descriptions of the performance are under consideration. (R.V.J.)

11231 PULSE RECORDING BY MAGNETOPHONE AND AUTOMATIC POTENTIOMETER. A. N. Selant'ev (Khlopin Radium Inst., the Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1165-8(Sept. 1960). (In Russian)

The design is given of an installation for recording emissions of short half life products or in operations with coincidence scheme. The device consists of three delaying cascades and two controlling cascades. The pulses enter the magnetophone after passing the first cascade. The transformation block consists of amplifier penetration cascade, and control. After passing through the amplifier with amplification coefficient 1 to 10, the pulses enter into the delaying block. The first cascade transforms the incoming pulses into pulses of 100 μsec. The recording load on the magnetophone should not exceed 100 pulses/sec. (R.V.J.)

11232 AN OSCILLOSCOPE MONITOR FOR SCINTILLATION SPECTROMETERS. C. C. Harris, H. O. Eason, J. E. Francis, Jr., and P. R. Bell. J. Nuclear Med., 1: 280-4(Oct. 1960).

Gamma-ray counting with single-channel scintillation spectrometers is an established and useful tool in nuclear medicine. However, beginning users of spectrometers are often confused by the apparent complexity of the instruments. Even operators with some experience are sometimes disturbed by misbehavior of the instruments, whether the misbehavior is major, minor, or simple misadjustment. An auxiliary device has been developed which eliminates guesswork in adjusting a spectrometer to count a certain region of a γ-ray spectrum. This device will also enable an operator to quickly determine whether apparent instrument failure is real or a result of misadjustment. This oscilloscope monitor is simple but effective. (auth)

11233 CONSTRUCTION AND STUDY OF A BISMUTH FISSION CHAMBER, DETECTOR FOR HIGH ENERGY NEUTRONS. L. Kowalski (Faculté des Sciences, Orsay, France). J. phys. radium, 21: 779-82(Nov. 1960). (In French)

A multiplate bismuth fission chamber was constructed which constitutes a threshold detector for neutrons of more than 50 Mev. This chamber is used as a monitor of the neutron beam of the Orsay synchrocyclotron. (auth)

11234 ISOTOPE SEPARATOR WITH DOUBLE MAGNETIC DEFLECTION FOR THE PRODUCTION OF VERY HIGH PURITY ISOTOPES. R. Bernas, J. L. Sarrouy, and J. Camplan (Faculté des Sciences, Paris). J. phys. radium, 21: 191A-203A(Nov. 1960). (In French)

The electromagnetic separator of the Nuclear Physics Laboratory of Orsay is made up of a 60° sector homogeneous magnetic field analyzer followed by a semi-circular inhomogeneous field analyzer of the Svartholm-Siegbahn type. The enrichment factors reached are from 10 to 100 times higher than those obtained with the other types of separators while the ion beam intensity remains in the neighborhood of 1 ma. A description of the instrument is given as well as the first results obtained in the separation of the isotopes of a few elements: Cr, Sr, Yb, Hg, and U. (auth)

11235 PRECISE MEASUREMENT OF TIME INTERVALS OF THE ORDER OF A MICROSECOND. Jean Bourguignon. J. phys. radium, 21: Suppl. No. 11, 217A-18A (Nov. 1960). (In French)

Time measurements by the classic oscillographic method present numerous disadvantages. A measurement method is described that uses a classic oscillograph with a simple modification which does not prevent its use in a classic way. This measurement method can be very accurate. (auth)

11236 STUDY OF SPARK COUNTERS OF THE ROSENBLUM TYPE FOR COUNTING α PARTICLES AND NEUTRONS. Suekichi Kawata (Kōnan Univ., Kobe, Japan). J. Phys. Soc. Japan, 16: 1-6(Jan. 1961). (In English)

Characteristics of the Rosenblum type spark counters were studied experimentally. In the case of a single-wire counter, the number of counts was investigated when the α-particle source was moved parallel to the cathode plate, in relation to voltage applied to the anode wire, and also when the source was moved perpendicularly to the cathode plate. The effects of temperature, pressure, and humidity of the surrounding air on counts were investigated, and the efficiency of counting of α particles was estimated. Experiments were also carried out for a multiple-wire coun-

ter. A counter with 14 anode wires was constructed, and it was found that uniformity of counting through the whole acting region would be greatly improved by inserting a high resistance in series with each wire. A neutron detector was constructed by putting a boron-coated glass plate above the multiple wires and surrounding the counter with paraffin. (auth)

11237 COUNTING EFFICIENCY OF GAMMA RAYS IN COUNTER TUBES. Tatsusaburo Suzuki and Jiro Yuhara (First Research and Development Center, Technical Research and Development H. Q., Japan Defense Agency, Tokyo). J. Phys. Soc. Japan, 16: 152-6(Feb. 1961). (In English)

The counting efficiency of γ rays in cylindrical counters and end-window counters is examined by means of a very thin sheet and a collimated fine pencil beam of γ rays. The distribution of the number of γ rays emitted from the thin slit is measured by means of an end-window counter or by the effect of the fine anode wire of the cylindrical counter. When the plane of thin sheet of γ rays reaching from side to a cylindrical counter is parallel to the axis, the counting efficiency registers a maximum value at the position where the sheet of γ rays is in contact with the inner surface of the counter, and a smaller value near the central wire, but when the pencil beam of γ rays is parallel to the anode wire and the γ rays entering the counter through the end-window plate, the counting efficiency gives a maximum value at the anode wire and the inner surface of the counter. An average efficiency for a sheet of γ rays which are in a plane perpendicular to the counter axis is also investigated. (auth)

11238 FAST COUNTING OF ALPHA PARTICLES IN AIR IONIZATION CHAMBERS. Z. Bay, F. D. McLernon, and P. A. Newman. J. Research Natl. Bur. Standards, 65C: 51-5(Jan.-Mar. 1961).

It was assumed in the past that counting of alpha particles in air-ionization chambers could be based only on the collection of ions since electrons produced in the alpha track quickly form negative ions in electronegative gases. This leads to time resolutions of the order of a millisecond. It is shown that the motion of the electrons before attachment produces a sharp initial rise in the pulse profile which, although small, can be detected and utilized for high-speed counting. Time resolutions of the order of a few microseconds with good signal-to-noise ratios are realized in atmospheric air, and therefore counting speeds similar to those in nonelectronegative gases are obtained. (auth)

11239 GAS FLOW COUNTER USING A COMPLEX HYDROCARBON MIXTURE. C. H. Parekh (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India), D, 20: 1-3(Jan. 1961).

The use of 'burshane,' a domestic fuel, as a detecting medium in gas flow counters was investigated. The results obtained using a polonium source indicate that burshane can be used as a substitute for the comparatively costlier gases used in gas flow counters such as argon and chemically pure methane. Small variations in the percentage composition of burshane or the flow rate do not have any effect on the counting rate. The gas multiplication increases exponentially with anode voltage. The counter is now being tried out for the detection of soft β particles. (auth)

11240 MASS SPECTROMETER FOR THE ISOTOPIC ANALYSIS OF LITHIUM. R. G. Ridley and D. E. P. Silver (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Sci. Instr. 38: 47-51(Feb. 1961). (In English)

A mass spectrometer was designed for the routine analysis of lithium. Microgram samples of lithium nitrate are ionized in a thermal ionization source. A 60° sector magnet analyzes the two ion beams that are collected simultaneously on two separate collectors. The source is pulsed and the two signals are a-c amplified and then subtracted from one another. The difference is displayed on a cathode-ray tube and the ratio is given rapidly by reading attenuation dials after adjusting for a null deflection. A calibration technique corrects for unequal transmission through the spectrometer and for inequalities in the circuitry. The precision of a single measurement of isotope ratio is ±0.7%. (auth)

11241 MODIFICATION TO THE MODEL 540 SCANNING COUNT INTEGRATOR. E. Mariniansky (Atomic Energy Commission Labs., Rehovoth, Israel). J. Sci. Instr. 38: 60-1(Feb. 1961). (In English)

The model 540 scanning count integrator, which programs the operation sequence of a single-channel scintillation spectrometer, is modified so that the sequence is stopped automatically after the recording of one spectrum cycle of 100 channels. The modification consists of adding several resistors and making use of some partially utilized components in the instrument. (D.L.C.)

11242 THE MEASUREMENT OF FAST NEUTRON DOSE BY MEANS OF NUCLEAR EMULSIONS. Jirina Matoušková and Jarmila Holanova (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderná energie, 7: 2-5(1961). (In Czech.)

The determination of the sensitivity of a nuclear emulsion produced in Czechoslovakia to fast neutrons is described. The dependence of the sensitivity on the shape of neutron spectrum is discussed, and an informative determination of the influence of the orientation of emulsion plates against a neutron beam is made. (auth)

11243 MEASUREMENT OF LOW RADIOACTIVITY IN WATERS. PART III. THE DESIGN OF A CELL COUNTER. Jarmila Rálková and Jaroslav Slunečko (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderná energie, 7: 13-15(1961). (In Czech.)

An improved arrangement of a cell counter and its anticoincidence circuit are described in detail. The background of the instrument is 0.8 amp/min, and geometric effectiveness is 94%. The counter enables the measurement of water activity beginning with the value 5.10^{-11} curie/liter, and after 10-fold thickening of the solution it is able to detect the activity prescribed by Czechoslovak standard for drinking water. (auth)

11244 A TIMING UNIT FOR NUCLEONIC COUNTING. W. G. Duncombe (Wellcome Research Labs., Beckenham, Kent, Eng.). Lab. Practice, 9: 858-60(Dec. 1960).

An apparatus was designed for the time control of a scaler used for radioactivity measurements. It has a range of 1 min to more than $1\frac{1}{2}$ hr. It can also be used for controlling an automatic sample changer. In operation, a contactor delivers a pulse every minute to the coil of a uniselector, causing the wiper arms to move on by one step. After the required number of minutes, preselected by a switch, the wiper arms close circuits which stop the scaler and reset the uniselector to its "off" position. The timer will then not operate again until the scaler is reset. A complete diagram of the circuit is included. The performance of the timing unit was checked by counting the 50-count/sec test facility of the scaler for different times. It was found that the greatest deviation from the expected counts corresponded to a time difference of about 0.1 sec, whatever the counting period. (M.C.G.)

11245 PNEUMATIC GAGES FOR IN-PILE MEASUREMENTS. J. Pefhany (Orenda Engines, Ltd., Toronto). Nuclear Eng., 6: 77-9(Feb. 1961).

A study was made of pneumatic gages to develop one with a range of 0 to 0.020 in. with a high resolution (2 to 5 μ in.) for use in a reactor. The design arrived at is described, and its characteristics discussed. If was found in the study that the maximum errors to be expected are in the order of 0.1% of full scale per 1000 hr of operation at 400°C. Much higher temperatures are possible with little change. Pneumatic gages may then be used for critical in-pile measurements. (T.R.H.)

11246 GAMMA-RAY MEASUREMENTS BY THE MAGNETIC ANALYSIS OF COMPTON AND PHOTO ELECTRONS. Milorad Mladjenović (Inst. of Physics, Faculty of Natural and Mathematical Sciences, Belgrade). Nuclear Instr. & Methods, 10: 1-23(Jan. 1961). (In English)

A review is presented of gamma spectra measurements by external photoconversion and by production of relatively narrow Compton lines. The effects of scattering, energy losses, and geometry on the intensities and energies are discussed. Some spectrometers especially designed for measurements of Compton spectra are also briefly reviewed. (auth)

11247 FAST TRANSISTORIZED PULSE HEIGHT ANALYZER. Alessandro Alberigi Quaranta and Bruno Righini (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuclear Instr. & Methods, 10: 25-30 (Jan. 1961). (In English)

A completely transistorized single-channel pulse-height analyzer with a dead time of 0.13 μsec is described. The channel width is determined by the passive characteristic of a delay line and is a constant percentage of the discriminator setting. Circuit diagrams and calibration curves at various frequencies are given. (auth)

11248 USE OF (p,γ) REACTIONS IN THE EFFICIENCY CALIBRATION OF A NaI CRYSTAL. K. J. Van Oostrum and A. C. Meijer (Technische Hogeschool, Delft, Netherlands). Nuclear Instr. & Methods, 10: 31-6(Jan. 1961). (In English)

The determination is described of the efficiency of a NaI crystal counter for detecting gamma rays with energies up to 6 Mev. The usual two-lines method was applied to low-energy gamma rays by using radioactive samples and to gamma rays with energies above 3 Mev by using (p,γ) reactions. Cascades of gamma rays and annihilating positons are then used in an extension of this method. Various necessary corrections are discussed. The purely experimental results are compared with those of the semiempirical approach usually applied for these high gamma-ray energies. (auth)

11249 THEORY OF "ION-BUNCHING" IN RELATION TO THE DEVELOPMENT OF AN ELECTROSTATIC TIME-OF-FLIGHT MASS SPECTROMETER. P. K. Dutt (Saha Inst. of Physics, Calcutta). Nuclear Instr. & Methods, 10: 37-44 (Jan. 1961). (In English)

A theoretical expression was worked out up to a first-order approximation for the shape of electrostatic pulse necessary for the acceleration of ions of any particular mass from the ion source to get them bunched at an instant during their flight in field-free space afterwards. Prior to the "pulsed" acceleration, the ions from the source are supposed to undergo steady (d-c) acceleration. An expression for the resolving power of an instrument utilizing the time-of-flight principle was put forward. The factors affecting the resolution are discussed. The effect of space charge on bunching was not taken into account. (auth)

11250 SOME EXPERIMENTS ON MOISTURE DETERMINATION WITH BETA-RAY TRANSMISSION. T. Westermark (Royal Inst. of Tech., Stockholm), B. Sjöstrand, and H. G. Forsberg. Nuclear Instr. & Methods, 10: 45-7(Jan. 1961). (In English)

By using a transmission geometry of beta rays from Pm^{147}, the recording of moisture changes in hydrophilic materials—kinetics as well as equilibria—is readily achieved. Some data from experiments on filter paper are described, and further applications are discussed. (auth)

11251 BETA-RAY SPECTROMETER WITH CURVED EXIT SLIT. H. Daniel and L. Jackson Laslett (Ames Lab., Ames, Iowa). Nuclear Instr. & Methods, 10: 48-52(Jan. 1961). (In English). (IS-156)

Computer calculations were performed for a high-resolution beta-ray spectrometer with a curved exit slit. Models with focusing angles of 324.50, 484.66, 655.21, and 829.74° were explicitly treated. Results are given for the shape of the exit slit and for the resolution and transmission. (auth)

11252 A dE/dx−E COUNTER TELESCOPE FOR CHARGED PARTICLES PRODUCED IN REACTIONS WITH 14 MEV NEUTRONS. L. G. Kuo, M. Petravić, and B. Turko (Institute Ruder Bošković, Zagreb). Nuclear Instr. & Methods, 10: 53-65(Jan. 1961). (In English)

A dE/dx−E counter was constructed for measuring angular distributions of charged particles produced in reactions with 14-Mev neutrons. Several requirements on such an instrument are considered with regard to particle selection efficiency, background, angular definition, and counting rate. Optimum design with a given angular definition is discussed. Actual performance of the counter is presented, and possible improvements are suggested, especially with regard to background. (auth)

11253 WIDE BAND DETECTION OF SMALL ION BEAM CURRENTS. A. N. James and C. M. P. Johnson (Cavendish Lab., Cambridge, Eng.). Nuclear Instr. & Methods, 10: 68-9(Jan. 1961). (In English)

An apparatus is designed for generating timing signals in ion beams in a 1.4-Mv Cockcroft-Walton generator. In operation, a beam strikes a tungsten wire, forming secondary electrons that are accelerated to a plastic phosphor; an output current is produced in a photomultiplier coupled to the phosphor. The size of output can be maintained at the same value for a 10:1 variation in beam current by varying the wire potential. The apparatus, used with a NE 102 phosphor and a RCA 6655 photomultiplier, gave 5×10^6 timing signals per second with no loss in phosphor efficiency or photomultiplier gain for two years. (D.L.C.)

11254 EXPERIMENTS USING ULTRA-FAST PULSE TECHNIQUES. G. Goldring (Weizmann Inst. of Science, Rehovoth, Israel). Nuclear Instr. & Methods, 11: 29-38 (Jan. 1961). (In English)

Lifetime measurements were carried out at the Weizmann Institute for low-lying levels of a number of odd-A nuclei in the rare-earth region. The mean lives are in the range of 3 to 20×10^{-11} sec, and a special method was developed for the measurement of these short times. This consists of a microwave beam pulsing device which chops the charged particle beam producing the excited level at a frequency of 2500 Mc/sec, and a combination of a β-ray spectrometer and a microwave cavity modulating the energy of the electrons and acting as a timed shutter for conversion electrons emitted in the decay of the excited state. The time resolution in these experiments was 7×10^{-11} sec. The ultimate time resolution that can be achieved is deter-

mined by the optical properties of the particle beam and the power available for the microwave deflection. (auth)

11255 MILLIMICROSECOND PULSING. Richard J. Connor (High Voltage Engineering Corp., Burlington, Mass.). Nuclear Instr. & Methods, 11: 122-5(Jan. 1961). (In English)

Apparatus for the production of short intense bursts of positive ions is in an early test stage at Burlington. The positive ion pulses are generated in the terminal of a 3-Mv accelerator by deflecting a d-c beam across a small aperture. The pulses after acceleration are swept across a Mobley type compression magnet. The pulses generated in the terminal are of 1-mA intensity and 10-mμsec duration: on traversing the post acceleration compression magnet the pulses will be compressed in time by a factor of 10 with the resultant increase in beam intensity to 10 mA. Some of the design considerations and anticipated problem areas are discussed. (auth)

11256 DIGITAL MAGNETIC RECORDING SPEEDS NUCLEAR EXPERIMENTS. John R. Waters and J. Roger Bird (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucleonics 19: No. 3, 70-5(Mar. 1961).

A magnetic-tape data-handling system was developed at Harwell to meet the needs of neutron physics groups for many time-of-flight analysis channels. In this system, 16-bit binary words are recorded across a 1-in. magnetic tape, and the recorded information is played back into a 1023-channel analyzer at 10 to 100 times recording speed. In this way, it is possible to conduct several neutron experiments at the same time using several recorders with one analyzer. A new writing method was developed in which zero is represented as a negative pulse. Other features of the system are discussed, e.g., the analog-digital converter and analyzer (a new analyzer was built with a capacity of 65,000 counts per word). The possibilities of the system are treated, such as building up three-dimensional graphs for the nuclear experiments. A comparison between magnetic tape, paper tape, and punched cards is made. (D.L.C.)

11257 ALLOYED SILICON DIODES AS PARTICLE COUNTERS. H. D. Engler (Siemens-Schuckertwerke A. G., Erlangen, Germany). Nukleonik 2, 215-22(Nov. 1960). (In German)

Alloyed silicon diodes of a special type were studied for their suitability for the detection of α or β particles and for γ quanta and neutrons. They are shown to be suitable for the measurement of these particles. The use of these diodes also permits the spectrometry of α particles. The limits of usefulness of these diodes as particle counters are discussed. (tr-auth)

11258 RELATIVE MEASUREMENTS OF ORGANIC SCINTILLATORS. Antoni Mank and Jan Malesa (Instytut Tele- i Radiotechniczny, Warsaw). Nukleonika 5: 149-56 (1960). (In Polish)

The γ radiation from Cs^{137} was used to produce light in organic scintillators. The light pulses were converted to electrical pulses by a photomultiplier tube. The pulses of electrical current were analyzed by three different methods to obtain a suitable method of determining the relative yield of a number of organic phosphors. The pulses were displayed in the form of a differential pulse-height spectrum and an integral pulse-height spectrum, and finally the average photomultiplier tube current was recorded for each phosphor. The differential pulse height spectrum gave the most information and is considered the most reliable method of comparing phosphor yields in that it singles out the forward-scattered Compton electron. However, the simple average-current method is satisfactory in the manufacture of a scintillator where the constituents and method of preparation are varied in maximizing the yield of light. Many complications that arise in comparing scintillators are discussed. These include the spectrum of emitted light, the spectral sensitivity of the photodetector, and the optical transparency and size of the scintillator. (TTT)

11259 A LOW LEVEL PULSE DISCRIMINATOR. Jerzy Czarnecki and Antoni Wykpisz (Wojskowa Akademia Techniczna, Katedra Radiologii). Nukleonika, 5: 157-60(1960). (In Polish)

A pentode and twin triode were employed in an RC-coupled bistable discriminator circuit that was linear in the range of 50 to 1500 mv. The circuit could be used directly with the output of a radiation detector, such as photomultiplier tube, and, therefore, eliminated the need of an amplifier. Change of heater-supply voltage or tube aging tended to produce a negligible effect on bias drift. A 10% variation in heater-voltage produced less than a 2 mv change of discriminator bias. Both a positive and negative voltage supply were required. Each had to have a 1 to 2% stability to yield a corresponding value of stability in bias level. The recovery time of the circuit was about 10 μsec. (TTT)

11260 A THREE-LEVEL MONITOR FOR IONIZING RADIATION. Jerzy Czarnecki (Wojskowa Akademia Techniczna, Katedra Radiologii). Nukleonika, 5: 161-4(1960). (In Polish)

A circuit employing a triode, three low-current relays (double-pole single-throw switches), and three neon glow tubes is discussed. In one mode of operation, one of the neon tubes is turned on when a predetermined level of nuclear radiation is reached. An additional tube is turned on for each of the higher levels. By increasing the value of one of the cathode resistors, the circuit can be made to operate in another mode. In this second mode of operation, all three neon lights flicker on and off when the radiation has reached the highest critical level. The repetition rate of this flicker is determined by the choice of the RC time constants associated with each of the three relay-circuits. This choice of repetition rate is useful in the automatic control of several processes with a definite rate of repetition. (TTT)

11261 BEHAVIOUR OF IONS IN MASS SPECTROMETERS UNDER PULSED REPELLER VOLTAGE CONDITIONS. A. Galli, A. Giardini-Guidoni, and G. G. Volpi (C.N.E.N., Rome and Università, Rome). Nuovo cimento (10), 18: 1277-9(Dec. 16, 1960). (In English)

To analyze the behavior of the ions in the source of a mass spectrometer, the repeller voltage was pulsed by square waves between positive and negative values with respect to the exit slit. Ions formed during the positive semiperiod only were observed; the frequency interval used was 0.002 to 2 MHz and the rise time of the wave was 0.1 μsec. The possibility of being able to follow the kinetics of approach to steady state conditions of the ionic current corresponding to the positive and negative values of the repeller voltage is studied. (T.R.H.)

11262 TRACKS OF COSMIC RADIATION PARTICLES OBSERVED IN NUCLEAR EMULSIONS. Marília Xavier de Morais. Publs. museu e lab. mineral. e geol. e centro-estud. geol. univ. Coimbra, Mem. e notíc., No. 48, 75-6 (1959). (In Portuguese)

During a study of α-particle tracks in nuclear emulsions that had been impressed by rocks, some tracks were found that could not have originated from these particles. It was concluded that they were produced by particles of cosmic radiation, either mesons or protons. The masses of the

particles could not be determined in the plates used (Ilford Nuclear Research Plate C_2). (auth)

11263 MEASUREMENT OF ABSORBED DOSE WITH CALORIMETER AND DETERMINATION OF W. W. B. Reid and H. E. Johns (Univ. of Toronto). Radiation Research, 14: 1-16(Jan. 1961).

The determination of energy absorbed through ionization measurements requires a knowledge of both ρ and W and a precise measurement of J. There is little justification for this involved procedure for determining energy absorbed when a single measurement with a calorimeter can determine the absorbed dose directly. For this reason it is recommended that standardization laboratories make absolute determinations of energy absorbed and use these to calibrate ionization chambers as secondary standards. This would be a major step forward in the precision of high-energy x- and γ-ray dosimetry. (auth)

11264 COMPTON DOSIMETER FOR MEASUREMENT OF PENETRATING X-RAYS AND GAMMA RAYS. Bernhard Gross (National Inst. of Tech., Rio de Janeiro). Radiation Research, 14: 117-30(Feb. 1961).

A unidirectional beam of photons in an insulator produces a directional current in the absence of an external electric field. This allows the construction of a γ-ray battery. In this battery a central electrode system measures the electrical current produced by the Compton electrons in an insulator placed on top of the electrode and also absorbs the γ-ray beam after its passage through the insulator-scatterer. The battery can operate in short circuit or in open circuit. Its output is proportional to the radiation dose. Backscattering and interface effects can be minimized by the use of a metallized dielectric in connection with the central electrode. (auth)

11265 RADIOPHOTOLUMINESCENT GAMMA-RAY DOSIMETRY OF MIXED NEUTRON GAMMA-RAY RADIATION FIELDS. C. G. Amato and S. J. Malsky (Brookhaven National Lab., Upton, N. Y.). Radiology, 76: 290-1(Feb. 1961).

A procedure is described for the convenient measurement of γ dose in a neutron-γ field. An unshielded radiophotoluminescent glass needle is used. The energy absorption due to neutron activation is calculated and this value is subtracted from the gross needle reading to give the γ dose delivered to the needle. (C.H.)

11266 RADIATION MEASURING PRINCIPLES. PART 2. A. Lagasse (Université Libre, Brussels). Rev. M.B.L.E. 3: 237-61(Dec. 1960). (In French)

The description of instruments transforming radiations into electrical pulses is continued. The operation principle of the first scintillation counter, the spinthariscope, and the progress that the use of photomultiplier cells has permitted in radiation detection with scintillators are reviewed. Some characteristics in the construction of scintillators are examined, and the phenomenology, efficiency, and background noise of the scintillation probe are studied. The diagrams of scintillation spectrometry in corpuscular radiations and gamma rays are analyzed. The use of a spectrometer permits the selective recording of a radiation with well-defined energy. The Cherenkov counter is discussed. The nature of the luminescent phenomenon involved is indicated, and it is shown how the Cherenkov effect can be utilized to detect fast particles. The operational principles of semiconductor counters are also briefly reviewed. (tr-auth)

11267 RESEARCH ON IONIZATION CHAMBERS FOR ISODOSE DETERMINATION IN PENDULUM IRRADIATION WITH ULTRAHARD X RADIATION FROM 15-Mev ELECTRON CENTRIFUGE-BETATRON. Franz Heinzler and Harald L. Mohr (Klinik fur Medizinische Strahlenkunde, Medizinische Akademie, Dusseldorf). Strahlentherapie, 114: 281-5(Feb. 1961). (In German)

Diagrams are submitted for both adjustment directions on the thorax-like water phantom—"lying" and "sideways elevated"—in order to find out the pendulum axis depth corresponding to each position of the maximum dose for each symmetrical pendulum angle up to ±90° during the pendulum radiation with ultra-hard beams of the Siemens-Reiniger-Werke 15.5-Mev betatron and to read off deep dose factors necessary for the evaluation of the maximum dose. (auth)

11268 USE OF ORDINARY PLATE GLASS AS A GAMMA-RAY DOSIMETER. Megumi Tashiro, Sumio Sakka, and Naohiro Soga (Kyoto Univ.). Yogyo Kyokai Shi, 68: 191-4(1960). (In Japanese)

The γ-ray dose rate distribution in a small closed space, 80 mm in diameter and 110 mm high, was determined by the use of small pieces of ordinary plate glass, 15 × 6 × 1.72 mm, as a dosimeter. The technique of the measurement is described. The advantageous features of the glass dosimeter, i.e., its small size, convenient usage, and preciseness in the measurement, are discussed. A brief description of the construction of a small Co^{60} irradiator, in which the measurement was made, is included. (auth)

11269 THE USE OF THE MAGNETIC SYSTEM WITH DOUBLE DEFLECTION FOR MASS-SPECTROMETER WITH HIGH DISPERSION. V. M. Kel'man, L. G. Knyaz'kov, and E. K. Vasil'eva (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 30: 1193-8(Oct. 1960). (In Russian)

Two schemes of double-focusing mass spectrometers using magnetic systems consisting of two opposed magnetic fields formed by spherical poles are described. It is shown that the described spectrometers are capable of high dispersion with comparatively small magnets. (tr-auth)

11270 γ-RAY ENERGY DETERMINATIONS. J. Warwick Knowles (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.350-65 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Methods for γ-ray measurements are discussed with respect to determination of nuclear reaction energies. The following instruments are reviewed: (1) γ-ray spectrometers (a) with low resolution and high efficiency and (b) with high resolution and low efficiency. (2) Spectrometers using coherent scattering (a) with curved crystal and (b) with double flat crystal. The neutron capture γ spectrum of Gd^{156} is given. Neutron capture γ rays in the reaction $H^1(n,\gamma)H^2$ were used to determine the deuteron binding energy, which was found to be 2227.0 ± 0.6 kev. (D.L.C.)

11271 ELECTRON ENERGY DETERMINATIONS. Robert L. Graham (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.366-83 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A review is presented on the recent developments in techniques for measuring the energies of decay electrons. Lens and flat type magnetic spectrometers are reviewed. Some results of Porter on the β spectra of H^3 and Re^{186} are presented as examples of electron energy measurements. Some developments in measurement of internal-conversion electron lines are described. It is concluded that accuracies ~10 ev or better should be possible in measurement of both extrapolated β spectrum end points and γ-transition energies. (D.L.C.)

11272 THE LARGE MASS SPECTROGRAPH IN THE MAX-PLANCK-INSTITUTE, MAINZ. H. Hintenberger, J. Mattauch, W. Müller-Warmuth, H. Voshage, and H. Wende. p.387-402 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A description is given of the large mass spectrograph nearly completed in Mainz, Germany. The spectrograph consists of six vacuum chambers and has first-order double focusing for all masses along a straight photographic plate and second-order direction focusing at the center of the plate. A standard electron bombardment ion source is used, and the total length of the ion path from the ion source to the photographic plate is ~15 m. The theoretical resolution with a 10^{-3} mm slit width is 2.5×10^6. The spectrograph operation is discussed in detail. (D.L.C.)

11273 THE ARGONNE 100 INCH RADIUS DOUBLE-FOCUSING MASS SPECTROMETER. C. Stevens, J. Terandy, G. Lobell, J. Wolfe, N. Beyer, and R. Lewis (Argonne National Lab., Ill.). p.403-17 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The Argonne 100-in.-radius double-focusing mass spectrometer, which combines high transmission and high analytical resolution, is described in detail. The double-focusing arrangement is a combination of a spherical electrostatic field with a magnetic field. Among the items discussed are the magnet, electrostatic analyzer, ion source, ion detector assembly, inter analyzer assembly, and vacuum system. A $CO^+ - N_2^+$ doublet spectrum at mass 28 is given which was taken with the source slits wide open (100% transmission). (D.L.C.)

11274 DESIGN OF A NEW RF MASS SPECTROMETER. Lincoln G. Smith (Princeton Univ., N. J.). p.418-31 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

General considerations are presented for the design of a device wherein, as in the mass synchrometer ions are separated according to their ratios of mass to charge by adjusting to high multiples of their cyclotron frequencies, the frequency (f) of a small r-f electric field in a "modulator" through which they pass during a very small part of their orbits in a uniform magnetic field. It also utilizes the perfect focusing of ions in space and time at integral numbers of turns from the modulator and their first-order focusing in angle at one-half turn from both the modulator and the source slit. It incorporates important improvements which allow attainment of significantly higher intensity, resolution, and accuracy of mass measurement than seem achievable with any mass spectrometer presently known. (auth)

11275 FIRST MEASUREMENTS WITH THE McMASTER DOUBLE-FOCUSING MASS SPECTROMETER. N. R. Isenor, R. C. Barber, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). p.439-45 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The mass spectrometer used in this work is briefly described, and the peak matching method of mass determination is outlined. Mass differences were measured for the following doublets: N_2O-CO_2, C_3H_7-$\frac{1}{2}Sr^{86}$, N_2O-$\frac{1}{2}Sr^{88}$, CO_2-$\frac{1}{2}Sr^{88}$, and $\frac{1}{2}Zr^{90}Cl_2^{35}$-$Kr^{80}$. Atomic masses computed from the doublets are 14.0075273 ± 15 for N^{14}, 85.93667 ± 5 for Sr^{86}, 87.933634 ± 18 for Sr^{88}, and 89.93350 ± 20 for Zr^{90}; comparisons are made with previous values. The corresponding values for the Sr^{88}-Sr^{86} and Zr^{90}-Sr^{88} mass differences are compared with those calculated from transmutation data. (D.L.C.)

11276 THE MASS SPECTROMETER AT HARVARD UNIVERSITY. [PART] I. K. T. Bainbridge and Parker E. Moreland, Jr. (Harvard Univ., Cambridge, Mass.). p.460-73 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The Harvard mass spectrometer has been adopted for utilizing the peak comparison technique. Its current status, electric circuits, performance, and operation are discussed. (D.L.C.)

11277 A MASS SPECTROGRAPH FOR THE ANALYSIS OF PARTICLES OF HIGH KINETIC ENERGY. Heinz Ewald (Technische Hochschule, Munich). p.491-7 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A large mass spectrograph is described which was designed for the analysis of fission product rays emitted by thin fissionable sheets by means of their initial kinetic energies. The spectrograph has a toroidal condenser and radial second-order double focusing in the mass lines. Its length is ~14 m. (D.L.C.)

11278 THE INFLUENCE OF SECOND ORDER ABERRATIONS ON THE LINE SHAPE IN MASS SPECTROMETERS WITH FIRST ORDER DOUBLE FOCUSING. L. A. König (Max-Planck-Institut für Chemie, Mainz). p.498-506 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The influence of second-order aberrations on the line shape in mass spectrometers with first-order double focusing along a straight image curve is investigated. The mathematical method is outlined briefly. As an example, the line shape and the shift of the center of mass of the line caused by the influence of the second-order aberrations are given. The results show that the experimentally observed effects are essentially greater than the computed ones. Therefore these must be due to other reasons. However, the results give a limit for the best possible approximation of the real mass scale to the ideal mass scale in these instruments. (auth)

11279 PRELIMINARY REPORT ON A QUADRUPOLE SPECTROMETER OF HIGH RESOLUTION. R. Köhler, W. Paul, K. Schmidt, and U. von Zahn (Physical Inst., Bonn). p.507-13 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Since the resolution power of a quadrupole spectrometer is almost independent of mass, it should be able to compete with heavy mass measurements made by magnetic spectrometers. The basis of the design of a quadrupole spectrometer is given, and characteristics of the existing and planned spectrometers are presented. A resolution power of 15,000 is hoped for. Some preliminary mass determinations are reported for krypton isotopes and carbohydrates at mass numbers of 82 to 86. (D.L.C.)

11280 IMPROVEMENTS IN OR RELATING TO DEVICES FOR THE DETERMINATION OF CHANGES IN THE COMPOSITION OF GASES. Ernst Meili, Heinrich Derfler, and Thomas Lampart (to Cerberus GmbH). British Patent 855,111. Nov 30, 1960.

An improved fire alarm system is designed which uses two ionization chambers. One chamber has perforations while the other is not accessible to air, and both are series-connected with the end terminals connected to a voltage source. The chambers are dimensioned so that the cold cathode tube in the circuit ignites to operate a fire alarm only when the air composition is altered, e.g., by smoke particles. (D.L.C.)

11281 IMPROVEMENTS IN OR RELATING TO D. C. POLAROGRAPHS. Geoffrey Cecil Barker (to United Kingdom Atomic Energy Authority). British Patent 860,130. Feb. 1, 1961.

A circuit to provide a current which compensates for the residual current in a polarograph in order to improve the sensitivity is described. This circuit takes into account variations in the value of the differential double-layer capacity. The residual current-compensating circuit consists of a means for applying a small a-c voltage across the polarograph cell, means of deriving a d-c voltage proportional to the a-c current, a means of integrating this voltage, and a means for combining a compensating current proportional to the integrated voltage. Essentially the compensating circuit produces a current which accurately balances out not the absolute value of the residual current at the start of the polarogram but any changes in residual current during the recording. (M.C.G.)

11282 MANIPULATING DEVICES INCLUDING MASTER AND SLAVE PORTIONS. Frederick John Martin Griggs (to Pye, Ltd.). British Patent 860,158. Feb. 1, 1961.

A manipulating device for the remote handling of objects, which consists of master and slave portions, is described. The tongs of the slave portion are normally held in an open position by one or more springs. Operation of the control grip in the master portion, transmitted to the slave by means of one or more control wires running over guide pulleys, closes the tongs against the force of the springs. Means are provided by springs inserted into the wire connected to each limb of the tongs to prevent the control wire from becoming dislodged from a guide pulley should one of the limbs strike or be struck by an object. The springs are inoperative in normal operation, but act to take up slack in the control wires if one of the limbs hits an object. (M.C.G.)

11283 IMPROVEMENTS IN MEASURING DEVICES USING RADIO-ACTIVE MATERIALS. Gordon Francis Wellington Powell (to Molins Machine Co., Ltd.). British Patent 860,183. Feb. 1, 1961.

Radioactive scanning devices used for measuring the mass of a loose tobacco filler moving along a trough which confines the filler on the top and sides leaving only the top uncontrolled are described. The measuring unit is arranged so that two radioactive scanning devices are spaced lengthwise of the trough and situated so that one scans the moving filler from the open side of the trough and the other from the opposite direction. A change in filler mass will alter the response, but the double scanning will tend to compensate for variations due to disposition of the tobacco shreds. (M.C.G.)

11284 IMPROVEMENTS IN MACHINES FOR MANIPULATING CUT TOBACCO. Gordon Francis Wellington Powell (to Molins Machine Co., Ltd.). British Patent 860,184. Feb. 1, 1961.

Equipment is described for controlling the rate of cut or shredded tobacco feed as filler to cigarette-making machines. The equipment consists of a radioactive (β ray) scanning unit for the filler and a cooperative balancing unit. The rate of filler feed is adjusted in response to variations detected in the filler mass. (D.L.C.)

11285 IMPROVEMENTS IN RADIATION GAUGES HAVING IONIZATION CHAMBERS. Gordon Francis Wellington Powell (to Molins Machine Co., Ltd.). British Patent 860,187. Feb. 1, 1961.

A radiation gage for measuring the tobacco filler in a cigarette-making machine is described. The radioactive source may be Sr^{90} embedded in a solid silver strip. The cylindrical ionization chamber has a window and plate-like electrode lying in planes transverse to the plane of the window. A means of rotating the chamber is provided so that the electrode plates may be disposed of in different angular relationships to the radioactive source and tobacco filler interposed between the source and chamber. Thus different areas of the chamber are exposed to the radiation. Rotating the chamber then can afford a means of adjusting the sensitivity. The gas in the chamber may be nitrogen or a mixture of argon and carbon dioxide. (M.C.G.)

11286 A NEW OR IMPROVED BALANCING UNIT FOR USE WITH RADIATION GAUGES. Gordon Francis Wellington Powell (to Molins Machine Co., Ltd.). British Patent 860,188. Feb. 1, 1961.

A balancing unit for use with a radioactive scanning device in determining tobacco filler mass is described. In previous machines the balancing unit consisted of a piece of thin aluminum which was designed to offer the same absorption to radiation that a filler of the desired mass would offer, but in this case a movable aluminum absorber in combination with an air gap enables balancing to be achieved with much greater accuracy. The aluminum absorber consists of a pair of thin metal plates spaced apart to define two converging sides of an aperture and stretched in a slide movable in guides across the top of the ionization chamber. The slide can be calibrated to indicate the tobacco mass to which a particular setting of the balancer absorber corresponds. (M.C.G.)

11287 IMPROVEMENTS IN OR RELATING TO RADIATION DOSAGE METER CASSETTES. (to Kodak, Ltd.). British Patent 860,198. Feb. 1, 1961.

A radiation dosimeter case which consists of a receptacle and lid with rims in abutting engagement with one another and a detachable resilient band which fractionally engages the rims to secure the two parts together is described. The two parts may be made from various synthetic resins or from a transparent material to permit the contents to be examined without removing the lid. The case may be loaded with a photographic film or a crystalline material which changes color upon irradiation. The heavy metal filter may be uniformly dispersed in the synthetic resin from which the case is molded. This resin then absorbs the secondary electrons emitted from the metal. (M.C.G.)

11288 METHOD AND APPARATUS FOR DETECTING MINUTE CONCENTRATIONS OF GASES AND VAPORS. (to Mine Safety Appliances Co.). British Patent 860,576. Feb. 8, 1961.

An apparatus is designed for detecting a trace constituent in a gaseous mixture with an ionization chamber. In the apparatus, the mixture is exposed to a reagent as it enters the chamber, whereby nascent particulate matter forms from the constituent-reagent reaction; the effect of the particulate matter on the ionization current enables the concentration of the constituent to be measured. The following compounds may be determined in this way: hydrogen halides, NO, SO_2, halogenated hydrocarbons, and HCN. NH_3 is the reagent for all except HCN, for which HCl is the reagent, while the halogenated hydrocarbons must be pyrolyzed beforehand to yield a hydrogen halide which will react with

NH_3. The ionization chamber is described at length in Patent No. 860,577. (D.L.C.)

11289 IONIZATION CHAMBER. (to Mine Safety Appliances Co.). British Patent 860,577. Feb. 8, 1961.

An ionization chamber is described which can be used to detect minute quantities of a constituent in a gaseous mixture in accordance with the method given in Patent No. 860,576. The chamber comprises an outer electrode in the form of a hollow cylinder, a coaxial inner electrode, inlet means for introducing the mixture, a reagent which reacts with the constituent to form nascent particulate matter, and outlet means. (D.L.C.)

11290 PORTABLE SCINTILLATION METER FOR RADON OR OTHER ALPHA PARTICLE EMITTING GAS. Vital Max Marie Glaude and Daniel Boclet (to Commissariat à l'Énergie Atomique). British Patent 860,849. Feb. 8, 1961.

A portable scintillation meter is designed for detecting excess concentrations of radon or other α-emitting gases in air. The meter comprises a variable volume chamber with one wall formed by a detecting scintillator, a photomultiplier associated with the scintillator, and means for transforming the electron pulses into countable signals. The scintillator is a plate of methyl methacrylate covered by a layer of zinc sulfide and a film of corrosion-resistant plastic. (D.L.C.)

11291 PULSE INVERTING TRANSFORMER. Dick A. Mack. U. S. Patent 2,973,492. Feb. 28, 1961.

A transformer for inverting the polarity of short pulses is designed for insertion in a coaxial line. A cylindrical, conductive outer shell has input and output fittings at opposite ends. A section of coaxial line is disposed within the shell and is connected between the input and output fittings. The inner and outer conductors of the section are transposed across a gap to invert pulses. A high-permeability material is disposed in the space between the outer shield of the section and the shell to delay the return currents in the shell, thereby avoiding cancellation of an inverted pulse. (auth)

Materials Testing

11292 (KAPL-M-FKB-1) HARDNESS CONVERSIONS FOR ZIRCONIUM BASE ALLOYS. F. K. Blechinger and F. W. Kunz (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 16, 1961. Contract W-31-109-eng-52. 10p.

Hardness conversion curves in the range 100 to 600 DPH were obtained for zirconium-base alloys, utilizing conventional micro- and macrohardness techniques. Large standard deviations resulted in the Knoop hardness scale in the range 500 to 600 KHN with an applied load of 10 g. The utility and limitations of the hardness conversion curves are briefly discussed. (auth)

11293 (SCTM-432-60(71)) IMPULSIVE LOADING OF A CIRCULAR DISK. W. B. Murfin (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 15p.

The equations of motion of a uniform circular disk were solved for a general case of impulsive loading and for the specific case of uniform impulse. Equations are given for computing deflections, stresses, and edge reactions. An experiment is suggested for checking results. (auth)

11294 (TID-11365) RESILIENT CUSHIONING MATERIALS. L. T. Wilson (Sandia Corp., Albuquerque, N. Mex.). [1957]. 7p.

Presented at Sandia Packaging Symposium, October 21 thru 23, 1957.

A test program to determine dynamic and environmental properties of materials for use in packaging to cushion shock and vibration is described. Test data are given, and additional dynamic testing is recommended. (J.R.D.)

11295 (TID-11366) PROPERTIES OF ELASTOMERS APPLICABLE TO SHOCK AND VIBRATION ISOLATION FIELD. George W. Dyckes (Sandia Corp., Albuquerque, N. M.). [1957]. 8p.

Presented at Sandia Packaging Symposium, October 21 through 23, 1957.

Engineering properties of elastomers that should be considered in designing for optimum over-all performance in packaging are described. (J.R.D.)

11296 (TID-11367) SHOCK AND VIBRATION ENVIRONMENTS TO WHICH SPECIAL PACKAGING IS EXPOSED. R. T. Othmer (Sandia Corp., Albuquerque, N. Mex.). [1957]. 26p.

Presented at Sandia Packaging Symposium, October 21 through 23, 1957.

Information concerning the environments to which packaging is subjected during transportation is presented. Discussions of vibration on railroads, railroad shocks, truck transportation, aircraft transportation, ship transportation, and handling are included. (J.R.D.)

11297 (TID-11389) EXPERIMENTAL DETERMINATION OF DYNAMIC STRESS CONCENTRATION FACTORS IN RECTANGULAR STEEL BARS. Jerome E. Ligocki (New Mexico. Univ., Albuquerque). 1960. 92p. [For Sandia Corp.]. (SCDC-2140X)

Resistance strain gages were used on a rectangular steel bar to establish dynamic two-dimensional stress concentration factors in the vicinity of a $\frac{3}{8}$-in.-diameter hole. Results obtained indicate substantial agreement between static and dynamic stress concentration factors. The dynamic stress concentration factors were obtained in a region of the bar where plane stress conditions prevailed. The shortest pulse duration achieved in the tests was 50 μsec. The static stress concentration factors obtained in the experiments were compared with existing theoretical analyses for a hole in an infinite plate subjected to static loading. Experimental results obtained previously for a hole in a finite plate under static loading are discussed and compared with the results obtained in this series of experiments. Recent investigations concerning the values of dynamic stress concentration factors are also discussed. (auth)

11298 (TID-11712) STRESS-STRAIN CHARACTERISTICS OF MATERIALS AT HIGH STRAIN RATES. PART V. DYNAMIC COMPRESSIVE YIELD STRESSES. E. A. Ripperger (Texas. Univ., Austin. Structural Mechanics Research Lab.). Aug. 1960. 45p. For Sandia Corp. Contract AT(29-2)-621. (SCDC-2216 X)

Since the dynamic compressive yield stress of a material offers a convenient indication of the effects of strain rate and specimen geometry on the stress-strain characteristics of the material, a study was made of the dynamic yield stresses of two materials, tellurium lead and commercially pure copper. The results of this study show that measured yield stress varies widely under supposedly identical conditions of measurements. By making a sufficient number of measurements to provide reliable average results and by smoothing the data, some definite patterns in the results were developed. These patterns indicated that contrary to the findings of other investigators, lead is not essentially strain-rate sensitive and copper is strain-rate sensitive. It was also found that for both materials yield stress decreased with increasing length of specimen. For

lead, the yield stress increased with the radius of the specimen; but for copper, the reverse was true. Frictional restraint against lateral motion at the ends of the specimen did not appear to have any significant influence on the yield stress. Likewise, the condition of the lateral surface of a specimen did not appear to affect its dynamic yield strength. (auth)

11299 USE OF A TWO-CIRCLE DEVICE TO OBTAIN THREE-DIMENSIONAL NEUTRON DIFFRACTION DATA. B. T. M. Willis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Acta Cryst., 14: 90-1(Jan. 10, 1961). (AERE-R-3308). (In English)

In neutron diffraction studies, by mounting the crystal on a two-circle device placed on the central table of the spectrometer, three-dimensional data can be obtained from a pillow-shaped crystal with approximately the same accuracy as for the conventional two-dimensional arrangement. The device constitutes the φ- and χ-circles of a three-circle diffractometer. χ is a vertical circle and φ a circle which rotates as a whole about the horizontal x-axis. (M.C.G.)

11300 ENERGY-RICH RADIATION SOURCES FOR NON-DESTRUCTIVE MATERIALS TESTING. F. Malsch and R. Schittenhelm (Siemens-Reiniger-Werke A. G., Erlangen, Ger.). Atompraxis, 6: 470-6(Dec. 1960). (In German)

The article discusses the requirements for a radiation source with high-energy x radiation for nondestructive material tests, particularly for testing reactor parts. The possibility of meeting these requirements with various types of sources is discussed with reference to physical factors and technical considerations. In conclusion, the article describes the Siemens-Reiniger 18-Mev betatron, which meets all the requirements for testing thick-walled radiation bodies. (auth)

11301 NON-DESTRUCTIVE CONTROLS OF FUEL-ELEMENT CANS USED IN WATER-COOLED POWER REACTORS. Romano Gasparini (Società Elettronucleare Nazionale "SENN,"[Italy]). Ing. nucleare, 5: 205-13(Sept.-Oct. 1960). (In Italian)

It is necessary that the fuel-element cladding used in water-cooled power reactors be absolutely watertight for the life of the element. The quality control concerning the materials used for the cladding must be absolutely painstaking. The methods used for these controls must, at the same time, permit proper speeds of inspection. Two methods based on eddy currents and supersonants are examined, giving in each case the limits of sensitivity, obtainable speeds, and possible improvements. (auth)

11302 THE MEASUREMENT OF THE DENSITY OF MELTS. B. A. Glagovskiĭ. Izmeritel'naya Tekh., No. 12, 48-50(Dec. 1960). (In Russian)

The volume of a fused melt was obtained by determining the liquid level in a calibrated vessel. The weight of this definite volume was determined by means of a pressure transducer that forms part of a bridge circuit. The deflection of a cantilevered beam was registered on an oscillograph in weighing the melt. The output current was calibrated against a known weight corresponding to a definite deformation of the beam. The two bridge circuits (one for the volume and one for the weight determination) are shown in detail, and the operation is described for manual and automatic control. The usual error of the determination of the density of the high-temperature melt is 2.5%. (TTT)

11303 NEW DEVICES FOR THE STUDY OF THERMAL CYCLING OF METALS. D. Buttinelli (Università, Rome) and G. de Gregorio. Mat. ital. Atti motiz., 52: 842-8 (Dec. 1960). (In Italian)

A thorough description of the typical device used for studying the behavior of metals and metal alloys under thermal cycles is given. This device was designed and built at the Institute for Metallurgy and Metallography of the Rome University. As an example of the possible performances of the device, a brief summary is given of some experimental results obtained in the thermal cycling of some metals. The differences in behavior between uranium and other metals, such as zinc, aluminum, and cadmium, are shown. Although these latter metals showed a recrystallization process which, under given conditions, could lead to the monocrystal, in the case of uranium, there was evidence of a polygonization process and of the formation of subgrains. (auth)

11304 PREPARATION OF AEROSOLS FOR ELECTRON-MICROSCOPY. Ernest H. Kalmus (Los Alamos Scientific Lab., N. Mex.). Z. wiss. Mikroskop., 64: 414-18(1960). (In English)

A technique is described whereby fall-out particles from dust clouds, commonly called aerosols, may be prepared for observation with the electron microscope. Specimens were collected by means of various types of precipitators on membrane filters made from cellulose esters. During the process of dissolving this material in acetone, the particles adhering to the filter surface were transferred to formvar-coated specimen screens for observation in the electron microscope. Losses were negligible, residual filter background was eliminated, and particles were clearly visualized for measuring or qualitative differentiation. (auth)

11305 A MODIFIED ALUMINUM-PRESSING TECHNIQUE FOR MULTIPLE REPLICATION. J. H. Bender and E. H. Kalmus (Los Alamos Scientific Lab., N. Mex.). Z. wiss. Mikroskop., 64: 419-24(1960). (In English)

The preparation of aluminum oxide replicas by means of standard metallurgical equipment is described. The aluminum-pressing technique, based on principles of coining, was modified to permit two-sided as well as multiple replication. Essentially nondestructive, the method is applicable to a wide range of materials under varying surface conditions. Some results are presented. (auth)

11306 NONDESTRUCTIVE TESTING. Warren J. McGonnagle. New York, McGraw-Hill Book Company, Inc., 1961. 462p. $15.00.

A comprehensive treatment is presented on the principles, advantages, and limitations of various nondestructive testing methods. Among the testing techniques treated in detail are visual testing, pressure and leak testing, liquid penetrant inspection, thermal methods, x-ray and γ radiography, ultrasonics, dynamic testing, magnetic and electric techniques, and eddy-current methods. Other items treated are thickness measurements, spot tests, sulfur printing, spectrochemical analysis, spark testing, activation analysis, and residual stress. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

11307 (A/AC.82/G/L.445/Add.8) MESSUNGEN DER RADIOAKTIVITAT DER LUFT IM JAHR 1959. (Measurements of Radioactivity of the Air in 1959). (Austria. Zentralanstalt für Meteorologie und Geodynamik, Vienna). Nov. 8, 1960. 15p.

Daily tabulations of the air radioactivity measured at the Hohe Warte Vienna station are presented. Air was sampled by filtration every 24 hr, and the activity was measured at the end of 24 and 48 hr. Tables give the number of counts per minute for the paper just after removal from the suction tube, the count after 24 hr, the count after 48 hr, albedo of the filter foil, radioactivity of the air in 10^{-12} c/cm^3, and precipitation during the sampling period. (J.S.R.)

11308 (A/AC.82/G/L.505) THE TIME DEPENDENCE OF ATMOSPHERIC PRECIPITATION OF THE MAN/MADE RADIOACTIVITY. Jiri Horak Československá Akademie Ved. Geofysikalni Ustav, Hradec Králové). Jan. 16, 1961. 11p.

Measurements were made of radioactivity in atmospheric precipitation between January 1958 and June 1959. The character of the radiation was determined from the absorption curve in an aluminum absorber. The course of the curve was compared with the absorption curve of the radiation of a mixture of fission products three years old. Within accuracy limits, the two curves agreed well. From the results of the measurements it is concluded that eight months after the termination of weapons testing only long-lived fission products remain in the atmosphere. It is assumed that this activity is bound on small particles which settle on the earth's surface from the higher levels of the troposphere and from the stratosphere. The influence of mixing of differently aged mixtures of fission products in the atmosphere on results of measurements is discussed. (C.H.)

11309 (AERE-M-761) DISTRICT GAMMA RADIATION SURVEY AROUND A.E.R.E. HARWELL. Results for 1958 and 1959. A. Morgan (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 11p.

The results of a γ radiation survey carried out in the district surrounding the Atomic Energy Research Establishment, Harwell, during 1958 and 1959 are described. Dose-rate measurements were made at a large number of fixed points within this area using portable ratemeters. Over this period no variation in dose rate due to deposition of radioactivity originating in the Atomic Energy Research Establishment could be detected; the variations in γ dose rate observed were due to the deposition of fission products from nuclear test explosions and maximum levels were reached in May and June 1959. Since that period the dose rate has declined due to the reduced rate of deposition of fall-out and radioactive decay of fall-out already on the ground. (auth)

11310 (AERE-R-3358) RADIOACTIVE FALL-OUT IN AIR AND RAIN. D. H. Peirson, R. N. Crooks, and E. M. R. Fisher (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 52p.

Airborne particulate radioactivity in the vicinity of the United Kingdom has been sampled for a number of years in the lower stratosphere, in the troposphere, and at ground level. Measurements have been made of the total activity and of certain individual fission products. The results, reduced to monthly mean values, are tabulated and presented graphically. From these data and from rain water results previously published it is shown that the usefulness of the total activity as a biological or meteorological parameter is limited; the deposition of individual fission product activity by rain is a less consistent index of meteorological phenomena than the concentration of activity in air or in rain; the concentration of individual fission product activity in rain is proportional to that in air in the troposphere and for short periods bears a simple inverse relationship to rainfall; the seasonal variation of individual fission product activity observed in air and rain supports the view that this phenomenon has a meteorological origin; the concentrations in air and rain of long-lived fission product activity reached maximum values in 1959 and have since decreased significantly; from the ratios of certain fission products the proportion of new activity introduced by test explosions may be calculated for the latitudes of the United Kingdom; the proportions are different for the troposphere and for the lower stratosphere; and from a simplified calculation of the stratospheric inventory, a rough estimate is made of the stratospheric residence time. (auth)

11311 (CEA-1685) CYCLES URANIFERES ET THORIFERES A MADAGASCAR. (Different Periods of Uranium and Thorium Occurrence in Madagascar). M. Moreau (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 20p.

In Madagascar, the first uranium and thorium cycles are about 500 million years old. First, the thorium and uranium were concentrated preferentially in granitic and charnockitic zones in the forms of monazite, apatite, or zircon. Toward the end of the Precambrian period, metasomatic granites were produced, especially in the anticlinic zones (Andriba orthite granite). The end of this granitization is accompanied by the formation of the principal pegmatic areas with uranium niobotantalates, uraninite, and beryl, which is developed preferentially in the synclinal series with little or no migmatization. At the same time, along with a calcomagnesian series in the southern part of the island, an important uranium and thorium area appears, marked by the development of uranothorianite. The erosion of the metamorphic precambrian rocks introduces, in the detritic sediments of Karroo, large quantities of monazite, which has been recycled and concentrated by successive marine incursions up to the present epoch. In the region of Folakara a uranium mineralization appears in direct relation with carbonaceous material characterized by tourbes and lignites. The uranium deposited in the Pleistocene in the argilo-tourbeous formations of the Antsirabe basin is noted in contact with crystalline rocks. (tr-auth)

11312 (DASA-531) THIRD ANNUAL HASP BRIEFING. Technical Analysis Report. Albert K. Stebbins, III, ed. (Isotopes, Inc., Westwood, N. J.). Dec. 15, 1959. 116p.

The High Altitude Sampling Program was initiated by the Joint Chiefs of Staff in 1954 to determine the spread of weapon-produced fission products through the stratosphere. U-2 aircraft, operated by the Strategic Air Command, have been sampling stratospheric air at various altitudes along North-South paths in the Western Hemisphere from 70° South to 70° North since 1957. Isotopes Incorporated, the principal contractor in this program, has analyzed over 2000 samples to date. Meteorological correlation has evolved a model of the stratosphere which accounts for the nonuniform deposition of fission products. The total stratospheric inventory of Sr^{90} between November 1957 and November 1958 was found to be 0.9 megacurie. In spite of the large Russian injection in the fall of 1958, the Sr^{90} stratospheric inventory for the period January 1959 to September 1959 averaged 0.7 megacurie. The conclusion is reached that equatorial injections in the 1 to 5 megaton range have a stratospheric half-residence time of around 10 months, while injections in the polar and temperate regions have a stratospheric half-residence time of around 5 months. Larger yield tropical injections probably have

residence times on the order of several years. A special study of W^{185} injected during the HARDTACK operation has been made. Results show more details of the mode of stratospheric mixing and transport and support conclusions drawn from Sr^{90} analysis. A definite seasonal effect upon the rate of departure of debris from the stratosphere is shown. The major portion of the stratospheric debris moves into the troposphere through the mid-latitude tropopause break. By Jan. 1, 1960, 87% of all material injected into the stratosphere will be on the ground. Predictions of radiation dose from existing nuclear debris of biological significance are made. The total dose from all debris, even to infants born during peak activities, has probably been no more than 10% of MPC and by 1965 should be less than 1% of MPC. (auth)

11313 (DMIC-146) MANUAL FOR BERYLLIUM PROSPECTORS. W. L. Smith (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 18, 1961. 39p. Contract AF33(616)-7747. (PB-151105)

Likely geological environments, field tests, portable nuclear detectors for beryllium, determinative tests, and methods of evaluating deposits are described as an aid in prospecting for beryllium. Prices, marketing, purification methods, toxicity, and uses for beryllium are discussed. Characteristics of the beryllium minerals are included. (M.C.G.)

11314 (DTC-3) RADIOACTIVIDADE DE "FALLOUT" NO RIO DE JANEIRO. (Radioactivity of Fall-out on Rio de Janeiro). Bernhard Gross, Edgard Meyer, and A. Aron (Brazil. Comissao Nacional de Energia Nuclear). 1959. 17p.

Data are presented on the concentration of fission products from fall-out in air samples collected at stations throughout Brazil during 1956, 1957, 1958 and through April of 1959. The significance of nuclear weapons tests in the Northern hemisphere on fall-out radioactivity and particle size is discussed. (C.H.)

11315 (HW-67549) AN EOLIAN DEPOSIT BENEATH 200-WEST AREA. Donald J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland Wash.). Dec. 6, 1960. 11p. Contract AT(45-1)-1350.

Results of investigations are presented in a study of the buff-colored silt deposited on the erosional surface of the Ringold formation beneath the Hanford 200-West Area. The characteristics of this deposit are markedly different from those of either the underlying Ringold formation or the overlying Touchet sediments. Mechanical and mineralogical analyses of this material indicate that it is of eolithic origin and probably derived from the sediments which make up the upper portion of the Ringold formation. The average cation exchange capacity of this material is generally 50 to 75% higher than that of the remaining sediments which lie above the water table in this region. The high cation exchange capacity of the 70-ft-thick loess and its effects on the downward percolation of wastes results in a significant improvement in the disposal capacity of cribs located above it. (J.R.D.)

11316 (MITS-44) THE ADAPTATION OF NEW RESEARCH TECHNIQUES TO MINERAL ENGINEERING PROBLEMS. A Semi-Annual Progress Report for the Six-Month Period Ending April 30, 1960. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Apr. 30, 1960. 51p. Contract AT(30-1)-956.

A titration method was employed for the determination of adsorption isotherms and zero points of charge (zpc) of Ag_2S in electrolytes of different compositions and pH. The study of streaming potential measurements was continued, which resulted in a new method for measuring streaming potentials. This method will be used to study the surface properties of hematite. A surface chemical study of the ferric oxide solution interface is reported. An adsorption study is being made of the three-phase system, hematite-aqueous solution-organic liquid. Work was continued on the study of hysteresis of contact angles for the three-phase system water-organic liquid-mineral. A preliminary oxidation test is now being completed on sulfur. The test was made for the purpose of determining the concentration range for which analytical methods will have to be designed and also for determining whether or not the composition of the sample container has any effect on the test. Work was continued on the dissolution of zinc sulfide in acid media. The effect of temperature on flotation of uranium ores is being investigated. A study of the contact charging of dielectric minerals, when in the hydrophilic state and as influenced by temperature and by relative humidity, is underway. Studies are being made of the dimensional analysis of tumbling mills. (W.L.H.)

11317 (NP-9800) RADIOACTIVE AND STABLE ISOTOPES IN METEORITES. P. Eberhardt and J. Geiss (Bern. Universität). 1960. 60p.

An outline is presented of principal methods and possibilities for isotopic ratios in meteorites. The isotopic abundance variations are caused by radioactive decay, fission, or cosmic radiation. These effects create new nuclei with a specific production rate, upon which dating methods can be based. The methods for age determinations are discussed as: uranium-thorium-lead; rubidium-strontium; rhenium-osmium; potassium-argon; and uranium, thorium-helium ages. The impacts of cosmic radiation on meteorites are reviewed as solid-state and spallation effects. The existence was discussed of some radioactive isotopes with half lives of 10 to 50×10^6 years. Investigations on the content of primeval gases in meteorites are surveyed, and some results are tabulated. The isotopic composition of "normal elements" and their implications is discussed. (B.O.G.)

11318 (NP-9825) METODOS DE PROSPECCAO ELECTRICA ADOPTADOS NA JUNTA DE ENERGIA NUCLEAR. MEMORIA NO. 28. (Electrical Prospecting Methods Employed by Junta de Energia Nuclear. Report No. 28). C. A. Neves Ferrão (Portugal. Junta de Energia Nuclear, Lisbon). 1960. 57p.

The electrical prospecting methods are described which have been incorporated in the routine operations of the Prospecting and Mining Services. The methods are concerned with structure and are useful in prospecting for uranium, other minerals, and water. The methods were developed to complement other existing prospecting methods and to provide geological and structural information. (J.R.D.)

11319 (RME-94) RECONNAISSANCE FOR URANIUM IN THE UINTA BASIN OF COLORADO AND UTAH. E. A. Noble and E. C. Annes, Jr. (Grand Junction Operations Office. Exploration Div., AEC). Jan. 1957. 22p.

Weak uranium mineralization is widespread throughout the Uinta Basin of northeastern Utah and northwestern Colorada in rocks ranging in age from Permian to Eocene. No commercial ore bodies are known, although formations there have characteristics elsewhere considered favorable for ore deposition. Carbon is generally associated with uranium-mineralized rock, although uranium minerals also occur in open spaces along faults and joints in the absence of carbon. All uranium minerals identified are secondary. Wide differences in equilibrium are shown by assays; chem-

ical assays commonly show more uranium than would be expected from radiometric assays. Ratio of uranium to vanadium differs widely from place to place and within single deposits. (auth)

11320 (SCTM-389-60(72)) HIGH-ALTITUDE WINDS OVER THE SOUTHWESTERN UNITED STATES FOR JANUARY, FEBRUARY AND MARCH. Robert F. Gentzler (Sandia Corp., Albuquerque, N. Mex.). Nov. 1960. 11p.

Upper wind observations near 60,000 and 100,000 ft for eight stations in the southwestern United States for January, February, and March 1959 and 1960 were studied. Frequency distribution graphs of wind direction and wind speed classes were prepared. Average temperatures and heights were determined. (auth)

11321 (TEI-603) GEOLOGIC SUMMARY OF THE SAN JUAN BASIN, NEW MEXICO, WITH REFERENCE TO DISPOSAL OF LIQUID RADIOACTIVE WASTE. Charles A. Repenning (Geological Survey. Washington, D. C.). June 1959. 77p.

The San Juan Basin occupies about 20,000 square miles of northwestern New Mexico and adjacent parts of Colorado. A survey was made on the geology of the San Juan Basin as part of the Radioactive Waste Disposal Program being carried on by the Geological Survey on behalf of the Division of Reactor Development of the Atomic Energy Commission. Four types of reservoirs in the San Juan Basin appear to deserve consideration for possible storage of high-level liquid radioactive waste. These are in gypsum, limestone, shale, and sandstone. Gypsum appears more useful for the storage of sintered waste. Storage of liquid waste in limestone is possible, but it is uncertain whether or not the stored waste could be controlled. The construction of artificial reservoirs in shale units by hydraulic fracturing or deep-seated explosion has several advantages, the most significant of which is the relative certainty of confinement. Storage in permeable sandstone units is more favorable from the standpoint of heat control. (C.H.)

11322 (TEI-725) SUMMARY OF ROCK SALT DEPOSITS IN THE UNITED STATES AS POSSIBLE DISPOSAL SITES FOR RADIOACTIVE WASTE. W. G. Pierce and E. I. Rich (Geological Survey. Washington, D. C.). May 1958. 192p.

A survey was made on the rock-salt deposits of the United States as a part of the study of radioactive waste disposal. A thick salt bed, as a place for the storage or disposal of radioactive waste products, is viewed with favor because salt, being relatively plastic, seals itself and eliminates the likelihood of space within it coming in contact with ground water. Consequently information on the geologic occurrence of salt and the distribution, thickness, and depth below the surface of all of the known rock-salt deposits of the United States is assembled so that the possibilities of radioactive waste disposal in salt beds may be considered in conjunction with plans for the geographic location of power reactors and fuel-element processing plants. Salt deposits are widely distributed over the United States, being known to occur in 23 of the 48 states. Not only is salt widely distributed, but some of the deposits have a lateral extent of several hundred miles. Bedded salt does not commonly occur at the surface, however, because it is readily soluble and has been removed by solution. Consequently, most of the information on the thickness and extent of the salt is interpreted from drilling records. (auth)

11323 (AEC-tr-4207) BULLETIN OF THE COMMISSION ON THE DETERMINATION OF THE ABSOLUTE AGE OF GEOLOGICAL FORMATIONS. PARTS I AND II. Translated by U. S. Joint Publications Research Service, New York from Byulleten Komissi po Opredeleniyu Absoliutnogo Vozrasta Geologicheskikh Formatsii. Izdatel'stvo Akademii Nauk S.S.S.R., Moskva. Vypusk I, 1955; Vypusk II, 1957. Nov. 1960. 144p.

The age relations of granite intrusions of the Ukraine were investigated by using the argon method. New data are reported on the age of magmatic rocks of the Northern Caucasus. The effects of the emanation of radioactive elements from minerals on the determination of the absolute geological age were investigated. A comparative analysis was made of the leaching of uranium and radium isotopes from uraninite. The emanation capacity of uraninite was investigated with respect to radon, thoron, and actinon as a function of temperature. The distribution of radioelements in different sections of uraninites was investigated. A new method is reported for separating small amounts of lead, and a procedure is described for the determination of ionium. A roentgenometric study was made of the suitability of monazites for the determination of geological age. The occurrence of inert gases in meteorites and their isotope composition was investigated. The variations of neutron flux on the surface of the earth were investigated. Data are reported for the Soviet scale of (geologic) chronology. The argon method is investigated for determining geologic age. The isotope composition of uranium in meteorites was investigated. An investigation was also made of the actinium-radium ratio in minerals. (W.L.H.)

11324 (AEC-tr-4412) NUCLEAR GEOPHYSICS IN EXPLORATION OF ORE AND COAL DEPOSITS. Yu. P. Bulashevich, G. M. Voskoboinikov, and L. V. Muzyukin. Translated from Report No. RICC/309 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 21p.

Various types of core-sampling equipment are described which use radiation sources in searches and exploration of deposits of useful minerals. Surface or gamma-gamma core sampling using Co^{60} as a gamma source, selective gamma-gamma core sampling with source of soft radiation such as Se^{75}, neutron-neutron and neutron-gamma core sampling with polonium-beryllium as the source of neutrons, activation core sampling with a polonium-beryllium neutron source, and photoneutron core sampling with a gamma emitting Sb^{124} source have been employed in the exploration of ore and coal deposits. The basic problem of radioactive core sampling of ore is the differentiation of ore zones in a layer of the bore. The basic problem in coal deposits is the determination of the depth of the bed, the determination of the capacity and structure of the coal strata, and the determination of the ash content. Applications discussed include neutron methods for investigating bores, applications in density measurements and selective core sampling, and practical results of applications of radioactive core sampling in ore and coal deposits. (C.H.)

11325 (JPRS-7683) DANGER OF INCREASED CONCENTRATION OF C^{14} IN THE ATMOSPHERE. A. M. Kuzin. Translated from Vestnik Akad. Nauk S.S.S.R., 30: No. 9, 48-52(Sept. 1960). 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract No. 2951.

11326 NEW DATA ON BOLTWOODITE, AN ALKALI URANYL SILICATE. Russell M. Honea (Univ. of Colorado, Boulder). Am. Mineralogist, 46: 12-25(Jan.-Feb. 1961).

Boltwoodite is an alkali uranyl silicate with the composition $K(H_3O)UO_2(SiO_4)\cdot nH_2O$ where n is 0 to 1. Chemical analysis, recalculated after deducting impurities, gave 14.8% SiO_2, 68.5% UO_3, 9.4% K_2O, 0.4% Na_2O, and 6.9% H_2O.

The proposed formula is supported by infrared data, and the formula and other evidence indicate a relationship to kasolite. The strongest lines of the x-ray powder pattern are 6.81 (10), 3.40 (9), 2.95 (8), 3.54 (7), and 2.91 (7). Pseudomorphic aggregates were dense microcrystalline structures, pale straw yellow in color, and had a hardness of 3½ to 4. Optical studies indicated orthorhombic symmetry, but boltwoodite may be monoclinic with b-axis elongation. It occurs as a secondary mineral coating fractures and cavities, and as pseudomorphs after uraninite. Twenty-one localities representing a variety of geological environments are listed. Data are presented on the hydrothermal synthesis of potassium, sodium, potassium–sodium, and NH_4^+ analogs of the mineral. (auth)

11327 HELIUM IN LIMESTONE AND MARBLE. Fraser Fanale and J. L. Kulp (Lamont Geological Observatory, Palisades, N. Y.). Am. Mineralogist, 46: 155-67 (Jan.-Feb. 1961).

The helium and uranium content of a number of specimens of marble, Iceland spar, and fossil shell of known age were determined. The sedimentary calcite specimens contained only a small fraction of the helium expected, indicating that most of the uranium is external to the lattice. The marbles, in contrast, contained much more helium than was calculated from the age and the alpha activity. This appears related to the gaseous inclusions in these materials. (auth)

11328 RADIATION COLORATION OF SILICA MINERALS. Harold W. Kohn and Ben M. Benjamin (Oak Ridge National Lab., Tenn.). Am. Mineralogist, 46: 218-25 (Jan.-Feb. 1961).

Radiation-produced color centers in both natural and synthetic silicas are associated with impurity atoms, although these impurities per se are not sufficient to cause coloration since impure silicas do not always form color centers upon irradiation. For trivalent impurities the extent and type of coloration seems to depend more on the manner of incorporation rather than the identity of the impurity atom, although the identity will naturally affect the type of center formed. The degree of general disorder may be important, but specific defects, especially hydroxyl ions associated with positive hole traps, should also be considered. The difference in behavior of some natural specimens and specimens prepared or treated in the laboratory makes it doubtful that some of these natural quartz specimens were originally colored by ionizing radiation. (auth)

11329 THE APPLICATION OF RADIOISOTOPES IN HYDROLOGY. IV. MEASUREMENT AND DETECTION OF THE RADIOACTIVE TRACER I^{132}. PART 2. H. Moser and W. Rauert (Forschungsstelle für Radiohydrometrie, Munich). Atomkernenergie, 5: 462-71(Dec. 1960). (In German)

In the second part of the article on the detection of I^{131} in hydrology experiments, a second method for the detection of the isotope is described. This method is a direct measurement in the current. The detection sensitivity of the direct measurement by means of a scintillation counter is, at best, approximately 5×10^8 (counts/min)/(μc/cm^3). The same detection sensitivity can be reached in the sampling method by using a sample of 3.5 : 1. The precision and detection limits of both methods are estimated. Theoretical predictions were proved by laboratory and field experiments and can be partially used with other methods. (tr-auth)

11330 READING SEISMOGRAMS WITH DIGITAL COMPUTERS. W. M. Adams and D. C. Allen (Univ. of California, Livermore.). Bull. Seismological Soc. Am., 51: 61-7 (Jan. 1961). (UCRL-6024(Rev.))

A device that permits direct input of seismic traces into electronic digital computers is described. Examples of its use and its several merits are presented. The device makes feasible numerical analysis of data recorded in analog form on photographic film or paper. (auth)

11331 GEOCHEMISTRY OF THE RADIOACTIVE ELEMENTS IN THE OCEAN AND CHRONOLOGY OF OCEAN SEDIMENTS. Edgard E. Picciotto (Université Libre, Brussels). Ciel et terre, No. 3-4, 22p.(Mar.-Apr. 1960). (In French)

A review is presented of the state of research on the radioelements in the ocean and the chronology of ocean sediments. The principles of radioactive methods of age measurement are outlined. Tables are given showing the half life, concentration, isotopic abundance, and decay rates for natural radioisotopes in the ocean. The geochemical balance of isotopes in the three radioactive families in the ocean is shown. Data on the radioisotope content of recent pelagic sediments covering great ocean depths where sedimentation is slow are presented and discussed. Finally, chronological methods are discussed including those based on decrease of a cosmogenic isotope, decrease of ionium or protactinium, or increase of ionium and protactinium. 37 references. (T.R.H.)

11332 LEAD FROM TROILITE OF THE TOLUCA IRON METEORITE. R. R. Marshall and D. C. Hess (Univ. of Chicago and Argonne National Lab., Ill.). Geochim. et Cosmochim. Acta, 21: 161-4(Jan. 1961). (In English)

Lead was recovered from the Toluca meteorite troilite by dithizone extraction and by vaporization. Lead isotopic ratios were determined mass spectrometrically. With the assumption that the lead originally had the isotopic composition of primeval lead reported by Patterson, a lead-lead age of $4.69 \pm 0.12 \times 10^9$ years (PbT) or $4.76 \pm 0.2 \times 10^9$ years (T4) can be calculated for the iron meteorite. Because the meteorite contains much less Pb^{204} than primeval lead, it suggests that the Toluca iron meteorite was formed at approximately the same time as the stone meteorites. The possibility that the meteorite may have had a more complicated history should not be overlooked. (T.R.H.)

11333 HYDROLOGY OF TRITIUM IN THE OTTAWA VALLEY. R. M. Brown (Defense Research Chemical Labs., Ottawa). Geochim. et Cosmochim. Acta, 21: 199-216(Jan. 1961). (In English)

Tritium deposition in rain water at Ottawa, Canada, is reported for the years 1953 to 1959. Correlation with the tritium content of drainage water in the district has allowed study of the hydrodynamics of the water system. A turnover rate constant of 0.27 year^{-1} has been found for a storage reservoir of 2.1 m. The fraction of fresh precipitation in re-evaporated water has been estimated as 0.55 ± 0.1. A deposition rate of cosmic tritium of 1.3 ± 0.1 atoms/cm^2 sec has been obtained from early data. (auth)

11334 HYDROTHERMAL STABILITY STUDIES OF THE ZIRCON-THORITE GROUP. F. A. Mumpton and R. Roy (Pennsylvania State Univ., University Park). Geochim. et Cosmochim. Acta, 21: 217-38(Jan. 1961). (In English)

The stability relations among minerals of the zircon-thorite group and the effect of related oxides on them have been studied under both "dry" and hydrothermal conditions. The problem of "hydrous" zircons and its relation to the metamict state has been investigated both experimentally and theoretically. From the data it appears that hydrous zircons and thorites do not involve OH^- substitution for O^{2-} with omission of Si^{4+}, but rather are formed by strong water adsorption in metamictized zircon and thorite. The phase equilibrium involved in the thorite–huttonite polymorphism has been studied and it is concluded that hut-

tonite is the only stable polymorph of $ThSiO_4$. Zircon dissociates at 1550 ± 50°C to $ZrO_2 + SiO_2$. The Alkemade triangles in the ternary systems $ZrO_2-ThO_2-SiO_2$ and $ZrO_2-UO_2-SiO_2$ have been determined and a not-impossible diagram is presented for the system $ThO_2-UO_2-SiO_2$. The extent of solid solution between $ZrSiO_4-ThSiO_4$, $ZrSiO_4-$"$USiO_4$" and $ThSiO_4-$"$USiO_4$" is discussed in connection with the composition of natural zircon and thorite. The application of the experimental data to natural mineral assemblages is discussed. (auth)

11335 DEUTERIUM CONTENT OF MINERALS, ROCKS AND LIQUID INCLUSION FROM ROCKS. Nobuhide Kokubu, T. Mayeda, and H. C. Urey (Univ. of Chicago). Geochim. et Cosmochim. Acta, 21: 247-56(Jan. 1961). (In English)

Samples of some minerals, rocks and liquid inclusions from rocks have been analyzed for water and deuterium content of the water. Samples from Hawaii and Japan were selected with the prime objective of securing juvenile water. It is found that the water of these samples contains less deuterium than the average surface water of the earth, and it is concluded that juvenile water does not contain as much deuterium as the oceans. Possible explanations for the discrepancy are offered. Protium equivalent to about 4 per cent of the oceans has escaped from the earth with a negligible loss of deuterium. The earth at its formation acquired surface water of high deuterium content and deeply buried water of low deuterium content. It is pointed out that certain carbonaceous chondrites contain the highest concentrations of deuterium ever found in Nature, while others of this group contain water of about average terrestrial composition. Other samples of water have been analyzed and are reported even though the results do not contribute to the main problem. The results do not differ in any important way from others reported in the literature. (auth)

11336 A THEORY OF POLAR GEOMAGNETIC STORMS. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sydney). Geophys. J., 3: 314-32 (1960). (In English)

A third part of the hydromagnetic theory of geomagnetic storms is obtained. The first two parts deal with the storm-time variations Dst in terms of isotropically propagating hydromagnetic compression (first phase) and rarefaction (main phase) of the geomagnetic field and its plasma. The three phases of the longitude-dependent disturbance Ds, the first phase or Sc, the main phase, and the preliminary reverse are all accounted for in terms of hydromagnetic waves whose Poynting fluxes are directed along the magnetic lines of force. These disturbances originate from "electromagnetic friction" between the solar wind and geomagnetic lines of force near 06 and 18h local time. These lines of force are bent out of their meridian planes and cause two pairs of "twist" waves to reach the earth, being focused into relatively confined regions at high latitudes. These twists are stable or force-free and result in space-charge accumulations in the lower ionosphere where the resultant Hall current accounts for the observed disturbances. During the main phase the twists are maintained by a deformation of the geomagnetic field which was described in the first two papers (the geomagnetic "tail"). Thus the tail theory accounts for both Dst and Ds main phase. It is difficult to see how any ring-current theory or other theory dependent on trapped corpuscular radiation could account for the asymmetric features of a storm. The mechanism also provides the beginning of a theory of auroras. (auth)

11337 TRITIUM AND HELIUM CONCENTRATION IN METEORITES. J. Geiss, B. Hirt, and H. Oeschger (Physikalisches Institut der Universität, Bern, Switzerland). Helv. Phys. Acta, 33: 590-3(1960). (In German)

Tritium was extracted from the meteorites by melting samples with high-frequency heating in chambers with tritium-free hydrogen as carrier. The hydrogen obtained was oxidized to H_2O and separated from CO_2. This oxidation and separation was repeated three or four times. The tritium was then measured in a proportional anticoincidence counter. An isotopes analysis of helium was made with a 30-cm 60° mass spectrometer without source magnet. The results of the measurement are tabulated. Radiation ages of three chondrites were of the order of magnitude of 10^7 years, in agreement with previous measurements. (J.S.R.)

11338 NEON AND OTHER RARE GASES IN STONE METEORITES. P. Eberhardt and A. Eberhardt (Univ. of Calif., La Jolla). Helv. Phys. Acta, 33: 593-4(1960). (In German)

The concentration and the isotopic composition of neon was measured in eight stone meteorites. All the Ne^{21} found occurred by cosmic radiation-induced spallation. A comparison of the Ne^{21} concentration was made with the He^3 and Ar^{38} also produced by spallation. By use of radiochemical target data, it was concluded that the mean energy of the cosmic radiation on the meteorites was about 1 Bev. The constant He^3/Ne^{21} ratio showed that the Ne^{21} radiation age agrees with the He^3 radiation age. (J.S.R.)

11339 CURRENT THINKING ON METEOROLOGICAL INSTRUMENTATION FOR USE IN AIR POLLUTION PROBLEMS. Gerald C. Gill (Univ. of Michigan, Ann Arbor), Harry Moses, and Maynard E. Smith. J. Air Pollution Control Assoc., 11: 77-82(Feb. 1961).

Wind speed, wind direction, and stability are the meteorological elements most pertinent to the air pollution problem. Wind direction and stability need not be measured with great precision. Wind direction may be measured to eight or sixteen points and stability to five categories. Because of the rather high correlation recently found between atmospheric diffusion and wind direction variability, it is felt that the latter parameter should also be measured. Since continuous measurements result in a vast accumulation of data, the need for stability and wind data processing equipment at reduced cost is recognized. It is generally accepted that the establishment of a set of recommendations for use as a guide in obtaining meteorological measurements is most desirable. The beginning made by the Instrumentation Clinic in setting up a guide for meteorological measurements pertinent to air pollution should be extended. It is believed that a convenient means of doing this could be found in the establishment of a project at one of the universities having a staff both qualified and interested in carrying out the task. It is further recommended that such a project be sponsored by the American Meteorological Society or the Air Pollution Control Association and financed by one of the appropriate agencies. Benefits arising from an effective set of recommendations would result in more useful meteorological information for decision making, reduction of instrumentation costs due to standardization, valid comparison of meteorological data obtained at different locations, and saving considerable time by meteorologists and engineers in designing installations for obtaining meteorological data. (auth)

11340 THE RATIO OF INDUCED FISSION VS. SPONTANEOUS FISSION IN PITCHBLENDE AND NATURAL OCCURRENCE OF RADIOCHLORINE. B. T. Kenna and P. K. Kuroda (Univ. of Arkansas, Fayetteville). J. Inorg. & Nuclear Chem., 16: 1–7(Nov. 1960). (In English)

Chlorine was isolated from kilogram quantities of both Canadian and African pitchblende, exhaustively purified, and counted. The specific activity of chlorine obtained from African pitchblende was found to be 7 ± 1 dis/min per gram of chlorine, whereas that from Canadian pitchblende was 4 ± 1 dis/min per gram of chlorine. The ratio of induced fission of U^{235} vs. spontaneous fission of U^{238} in these minerals was calculated from the radiochlorine data. A value of 0.33 was obtained for the African pitchblende, and a value of 0.19, for the Canadian pitchblende. (auth)

11341 A PROCEDURE FOR THE CONTINUOUS DETERMINATION OF RADON IN ATMOSPHERIC AIR. APPLICATION TO THE PROSPECTION OF URANIUM. Daniel Blanc, Jacques Fontan, and Gilbert Vedrenne (Faculté des Sciences, Toulouse). J. phys. radium, 21: Suppl. No. 11, 176A-80A(Nov. 1960). (In French)

The apparatus allows a continuous recording of the radon content of atmospheric air. A very powerful pump sucks the air being analyzed through a paper filter, the efficiency of which is great enough to eliminate all radioactive particles in the aspirated volume. Any excessive charge loss can be avoided by the use of filters with large surface, in series. Then, the air goes into a leakproof disintegration chamber the capacity of which is several hundreds of liters. A part of the radon content is disintegrated in it; when leaving the chamber, the particles of radioactive products are collected by another paper filter having a great efficiency. The α activity of the filter is continuously measured with an integrator and a graphic meter. The device makes possible the dosage of radon concentration of 2×10^{-14} curie by liter. A "BABAR" type apparatus can be added to the device: it permits measurement of the activity of radioactive products of radon in air; the air passes through a filter of paper which unwinds before a photomultiplier, and such is the unwinding speed that activity due to the radioactive products of thoron is negligible. These devices, used together, allow a simultaneous registering of activity imputable to radon and to its radioactive products. The ratio between both activities is a function of the time at which the radon has been emitted from the ground; knowing wind direction and speed, localization of uranium deposits will be possible. This method is suitable for remote prospecting in regions of difficult access. (auth)

11342 A NOTE ON 'METAMICT ZIRCON' FROM KATTERI PEGMATITE, MYSORE. M. R. Srinivasa Rao and A. Achutha Rao (Central Coll., Bangalore, India). J. Sci. Research (India), B, 20: 34-5(Jan. 1961).

The salient features of the morphology, optics, x-ray, and spectrochemical analysis of a metamict variety of zircon from Katteri (Mysore) pegmatite are described. From these data it is concluded that metamicts invariably comprise zirconoids with zirconium/thorium elements replacing zirconium diadochically. Hence, the high radioactivity in metamicts is probably due to the presence of other radioactive elements in the zircon crystals. It is suggested that zirconoids occupy an intermediate position in the zircon-thorium-uranite group of minerals. (auth)

11343 ANALYSIS OF CRYSTAL STRUCTURE OF FLUORO-APATITE BY MEANS OF NUCLEAR MAGNETIC RESONANCE. Shoichi Hayashi (Univ. of Electro-Communications, Tokyo). Nippon Kagaku Zasshi, 81: 540-2(Apr. 1960). (In Japanese)

The structure of fluoro-apatite was investigated by the NMR technique. Two sample specimens used were the single crystals from Japan and Mexico. The resonance curves were recorded for F^{19} and P^{31}, respectively, by the autodyne type detector. The magnetic field was about 3900 gauss, and resonance frequencies were about 15.9 Mc for F^{19} and about 6.8 Mc for P^{31}. The second moments were 0.68 and 0.44 gauss for F^{19} and P^{31}. The second moments were also calculated theoretically by using the x-ray data with the results of 0.54 gauss and 0.15 gauss for F^{19} and P^{31}. In order to explain the discrepancies between the theoretical and experimental values of second moments, the second moment values were calculated for the models where the coordinates of phosphorus atoms were varied, and it was confirmed that the second moment value for a model is consistent with the experimental value where the coordinates for P^{31} are reduced by about 20% with respect to the x-ray data. Thus the coordinates for the fluoro-apatite are: F: 0,0,1/4; 0,0,3/4 and P: (x,y,1/4; $\bar{y}$,x−y,1/4; y−x,$\bar{x}$,1/4), x = 0.333, y = 0.289. (auth)

11344 GEOCHEMICAL STUDIES ON THE RADIOACTIVE SEDIMENTS. II. THE URANIUM CONTENTS IN THE NATURAL WATERS IN THE NINGYO-PASS MINING AREA. Masanobu Sakanoue (Okayma Univ., Tottori, Japan). Nippon Kagaku Zasshi, 81: 896-8(June 1960). (In Japanese)

To confirm how much uranium is being leached from the sedimentary rocks and moving in the present natural water, the uranium contents were determined on the samples of underground waters inside the drift of the Ningyo-Pass Mine as well as the surface waters of the rivulets and the stream near the mine. The sample waters were first filtered and acidified with nitric acid for storage. Uranium was concentrated by the coprecipitation with aluminum phosphate and then analyzed by the method of front paper-chromatography. The contents of uranium in the samples covered the range from some micrograms to some hundred micrograms per liter. From these results, it is likely that uranium is more reachable into the present natural waters from the unoxidized zone containing the uraniferous mineral "ningyoite" than from the oxidized zone containing autunite. This fact was confirmed in the laboratory leaching tests in which the ores obtained from both zones were leached with solutions of various pH. (auth)

11345 GEOCHEMICAL STUDIES ON THE RADIOACTIVE SEDIMENTS. III. URANIUM, PHOSPHORUS AND ARSENIC IN THE SEDIMENTARY ORE DEPOSITS NEAR NINGYO-PASS IN JAPAN. Nippon Kagaku Zasshi, 81: 898-902(June 1960). (In Japanese)

In order to throw a light on the origin of uranium ore deposits in the sandstone and conglomerate beds, these geochemical studies were made on Ningyo-Pass Mine, Japan. The uranium contents in many parts of those sedimentary beds were determined by the method of front paper-chromatography. The localities for the studies were the unoxidized zone where "ningyoite" was found, the oxidized zone where autunite was seen, their coexisting zone, and some shale beds containing fairly high amounts of uranium. The arsenic and phosphorus contents in the same sample were also determined by the improved Gutzeit method and the molybdenum blue method, respectively. As a result, it was found that the uranium and phosphorus contents in the unoxidized zone had a close interrelation, and it is likely that uranium in these sediments was deposited mainly as the compound whose composition is corresponding to "ningyoite," a new uranous calcium phosphate mineral. Furthermore, it was supposed from the relations between the contents of uranium and arsenic that the existence of pyrite having the high arsenic content would have some connection with the deposition of uranium. Moreover, the facts concerning the movement and concentration of uranium, phosphorus and arsenic in the oxidized zone were found. (auth)

11346 GEOCHEMICAL STUDIES ON THE RADIOACTIVE SEDIMENTS. IV. URANIUM AND GERMANIUM IN

THE CARBONACEOUS MATERIALS FOUND IN THE "MISASA-GROUP" SEDIMENTARY BEDS OF TERTIARY AGE. Masanobu Sakanoue (Okayama Univ., Tottori, Japan). Nippon Kagaku Zasshi, 81: 1520-3(Oct. 1960). (In Japanese)

In the "Misasa-group" sedimentary beds of tertiary age near Ningyo-Pass in western Japan many radioactive carbonaceous materials are found. The content of uranium, phosphorus, and sulfur in these samples was determined and their mutual correlations were investigated. By x-ray-diffraction methods, the existence of "ningyoite," the uranous calcium phosphate mineral, was identified in the lignite sample. Spectrographic and colorimetric analyses have shown unusually high percentages of germanium in these carbonaceous materials. On the basis of the results of the laboratory tests and the inverse relationship between the ash content and the germanium content in these samples, it was supposed that the high concentration of germanium was caused by the absorption of the element from solutions. Furthermore, the function of the carbonaceous materials on the deposition of uranium in the reducing environment was considered and the possibility of the effect of hot spring waters on these sedimentary beds was mentioned to explain the high germanium contents of these carbonaceous materials. (auth)

11347 GEOCHEMICAL STUDIES ON THE RADIOACTIVE SEDIMENTS. V. SULFUR AND URANIUM IN THE SEDIMENTARY URANIUM DEPOSITS. Masanobu Sakanoue (Okayama Univ., Tottori, Japan). Nippon Kagaku Zasshi, 81: 1523-7(Oct. 1960). (In Japanese)

To clarify the geochemical nature of the uranium deposits in the "Misasa-group" sedimentary beds in western Japan, total sulfur contents of the samples taken mainly from Ningyo-Pass Mine were determined by the tin(II)-phosphoric acid reduction method. From the result, it was found that the total sulfur contents had positive correlations with the contents of both arsenic and uranium in the samples from unoxidized zones of this area. On the contrary, in oxidized zones the total sulfur contents were small and independent of the contents of arsenic and uranium. The effects of hydrogen sulfide on the solutions containing uranyl ions were tested in the laboratory. The reactions in the presence of carbonate, phosphate, and calcium ions were also examined, and the results were compared with the reactions in the solutions without hydrogen sulfide. It was found from these experiments that hydrogen sulfide was able to reduce uranyl ion in hot solution and to precipitate uranous compound. From this fact, the function of the sulfide in the case of the deposition of uranium in the sedimentary beds was suggested. In conclusion, the problems of the origin of the uranium deposits in this area were considered in general. (auth)

11348 IONIZATION EQUILIBRIUM IN MARITIME AIR. T. C. O'Connor and W. P. Sharkey (University Coll., Galway, [Ireland]). Proc. Roy Irish Acad., A, 61: 15-27(Nov. 1960).

An investigation of ionization equilibrium in maritime air arriving at a station on the west coast of Ireland is reported. Simultaneous measurements of the size of the Aitken nuclei and the fraction of the nuclei that was charged were made and the results compared with the predictions of charge equilibrium in aerosols according to the Boltzmann law. The results indicated that equilibrium conditions generally prevail in air from the ocean. The effect on the measurements of the increased heterogeneity of the aerosol caused by the intrusion of small uncharged nuclei from natural sources in the littoral zone was examined. Possible origins of the nuclei observed are discussed. (auth)

11349 CONTRIBUTION TO THE KNOWLEDGE OF PORTUGUESE URANIUM MINERALS. J. M. Correia Neves and J. E. Lopes Nunes. Publs. museu e lab. mineral. e geol. e centro estud. geol. univ. Coimbra, Mem. e notíc., No. 48, 23-7(1959). (In Portuguese)

A study was made of Portuguese uranium minerals and several conclusions were reached. The uraninite of Urgeirica, identified by x-ray diffraction, had a differential thermal curve different from those listed in the literature. The differential thermal diagram of the sabugalite of Cortes Cimeira (Bendada) differs from those obtained previously. This mineral is closely associated with phosphuranylite. At Urgeirica and Reboleiro an α-uranophane was identified. A DTA curve with exothermal peaks at 100 and 725°C and endothermal peaks at 125 and 183°C was obtained from the Urgeirica α-uranophane. The metatorbernite and torbernite minerals appear to be always closely associated in nature. The two structures can however exist apart. Differential thermal study showed that it is possible to distinguish the torbernite from the metatorbernite. Optically, thermally, and by x rays, a perfect identity was found among the eleven autunites examined. (auth)

11350 RADIOACTIVITY OF A MONZONITE FROM FOZ DO DOURO (OPORTO). Marília Xavier de Morais. Publs. museu e lab. mineral. e geol. e centro estud. geol. univ. Coimbra, Mem. e notíc., No. 48, 59-75(1959). (In Portuguese)

The total radioactivity of a monzonite from Foz do Douro was measured, and it was found that its percentage of uranium is higher than that of the granitoid rocks and that its thorium percentage is higher than the average. A study of the crystals of this rock showed that the great concentration of thorium was in small crystals of zircon and malacon. The crystals of malacon in particular have very high percentages of thorium. Uranium appears in crystals of sphene, zircon, and malacon. The sphene crystals are numerous. Those of malacon generally have a higher concentration of uranium. (auth)

11351 APPEARANCE OF A SPRING MAXIMUM IN NUCLEAR TEST DEBRIS IN 1960. P. F. Gustafson, S. S. Brar, and M. A. Kerrigan (Argonne National Lab., Ill.). Science, 133: 460-1(Feb. 17, 1961).

The existence of a spring maximum in fall-out deposition due to the disruption of the tropopause in middle latitudes has been debated for the past several years. Evidence obtained from air filters indicates elevated levels of radioactivity from nuclear tests in surface air during April through July 1960. (auth)

11352 LATITUDINAL EFFECT IN THE TRANSFER OF RADIOCARBON FROM STRATOSPHERE TO TROPOSPHERE. Henrik Tauber (National Museum, Copenhagen). Science, 133: 461-2(Feb. 17, 1961).

Latitudinal variations in the descent of bomb-produced radiocarbon from the stratosphere are suggested by differences in tropospheric C^{14} activity. The magnitude of a similar latitudinal effect in the prebomb steady state is estimated. This effect may partly explain the short-term oscillations in C^{14} activity found in tree-rings from the last 1300 years. (auth)

11353 THE PRESENCE OF TRANSURANIC ELEMENTS IN NATURE. R. Tsaletka and A. V. Lapitskii (Moscow State Univ.). Uspekhi Khim., 29: 1487-97(Dec. 1960). (In Russian)

The various unsuccessful attempts to isolate transuranic elements in nature prior to the discovery of Pu^{239} in nature by Seaborg and Pearlman in 1942 are briefly reviewed.

Further investigations show that the ratio of Pu^{239} to uranium is $(2.0 \pm 0.3) \times 10^{-11}$, and that the ratio of Pu^{238} to Pu^{239} is less than 3×10^{-4}. If the half life of Pu^{244} is assumed to be 9.6×10^{7} years, it is possible that $\sim 10^{-13}$ gram of Pu^{244} may exist in 34 kg of thorium in a natural ore. The principal sources of neutrons in natural minerals are due to the fission of U^{235} and various (α,n) reactions. The ratio of Pu^{239} to uranium is low in minerals such as carnotite and tyrite because they have a low uranium content and a high content of other elements that absorb neutrons. If it is assumed that U^{233} is formed principally by the α decay of Np^{237}, the ratio of Np^{237} to U^{238} is $(1.8 \pm 0.4) \times 10^{-12}$ (according to Peppard). The role of the fission of Cf^{254} to explain the occurrence of supernovae is discussed briefly. 52 references. (TTT).

11354 THE STRUCTURE OF EPIDIDYMITE $NaBeSi_3O_7(OH)$. A NEW KIND OF INFINITE SILICILIC ACID CHAIN (STRIP) $[Si_4O_{15}]$. E. A. Pobedimskaya and N. V. Belov (Moscow State Univ.). Zhur. Strukt. Khim., 1: No. 1, 51-63(May-June 1960). (In Russian)

The structure of epididymite, the rare Na–Be silicate, found in the USSR in the Kola peninsula, was studied by means of x-ray diffraction using the superposition method. It was established that sodium polyhedra constitutes the basic building unit of the material; strips of Si_4O_{15} parallel to these units form twinned wollastonite-type chains. The Si_4O_{15} strips and beryllium tetrahedra form double layers perpendicular to the c axis of the crystal. The interatomic distances of the Si(I), Si(II), and Si(III) tetrahedra, beryllium tetrahedra and sodium polyhedra have been determined. The postulated structure explains well the observed physical properties of the crystal. The two mutually perpendicular cleavage planes (100) and (001) emphasize the closeness of this material to the structure of orthoclase. The closed double layers containing Si + Be tetrahedra are rotated in the direction of the (001) axis because the layers are separated by the large, hexagonally arranged sodium atoms. The multilayer structure explains the ease of cleavage of the mineral alongside the (110) plane. (TTT)

HEALTH AND SAFETY

11355 (A/AC.82/G/L.503) STRONTIUM-90 IN MILK 1957 to 1960 AND ITS RELATION TO RADIOACTIVE FALLOUT IN CENTRAL EUROPE. J. Nosek and V. Santholzer (Karlova Universita, Hradec Kralove, Czechoslovakia. Lekarske Fakulta. Ustav Fysiky). Jan. 16, 1961. 19p.

The minimum Sr^{90} content found in milk was 1.0 strontium units in January 1957 and September 1959 and the maximus value was 12.0 strontium units in December 1958. The Sr^{90} content in dairy milk was somewhat higher in the autumn of 1957 when several nuclear tests took place. A considerable increase was registered in the winter of 1958 and 1959 after a larger series of nuclear tests during 1958. Since the autumn of 1959, fall-out activity has decreased rapidly. In February 1960 about 0.5% as much activity as was measured in the second half of 1958 was found. This decrease is due to the temporary suspension of nuclear tests which began in November 1959. The systematic long-term study of decay curves of fall-out samples with high acitvity showed that in Europe highly active fallout represents an almost isolated set of fission products. Background due to previous tests was practically negligible. Sr^{90} and Y^{90} content do not exceed 1% of fall-out activity at present. (auth)

11356 (A/AC/82/G/L.507) A BRIEF SURVEY OF RESULTS OF MEASUREMENT OF FALLOUT AND RAINFALL STRONTIUM 90 IN FALLOUT AND MILK. W. Santholzer (Karlova Universita, Hradec Karlove, Czechoslovakia. Lekarske Fakulta. Ustav Fysiky). Jan. 16, 1961. 9p.

Data are tabulated on the radioactivity in samples of rainwater and Sr^{90} content in water and milk samples collected in Czechoslovakia between Nov. 1, 1956 and Jan. 31, 1960. (C.H.)

11357 (AEET/AM/16) CESIUM-137 IN MILK. K. G. Vohra, V. S. Bhatnagar, U. C. Mishra, and S. Ragupathy (India. Atomic Energy Establishment, Trombay). July 1960. 20p. (A/AC.82/G/L.515)

Samples of liquid milk from Bombay and 27 other stations in India, and imported powdered milk from Australia, Denmark, Holland, United Kingdom, and United States were measured for their Cs^{137} and P^{40} contents. The average Cs^{137} content of Bombay milk is 9.38 $\mu\mu c$ per gram of potassium for the year 1958, 18.26 for 1959, and 14.71 for the first two months of 1960. The increase in the average level of Cs^{137} by a factor of two during 1959 was attributed to the accelerated fall-out rate following the large number of tests conducted during the autumn of 1958. The Cs^{137} content in the Australian powdered milk is found to be about the same as in the European powdered milk and about 2 to 3 times that in the Indian powdered milk. There are large variations in the levels of Cs^{137} in different samples from India. The values range from 2.79 to 159.9 $\mu\mu c$ per gram of potassium, the highest values being for Gangtok. (auth)

11358 (ANL-6282) ENVIRONMENTAL RADIOACTIVITY AT ARGONNE NATIONAL LABORATORY. Report for the Year 1959. J. Sedlet (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-Eng-38. 50p.

The results of the environmental monitoring program at Argonne National Laboratory for 1959 are given. The radioactive content of the environment was measured by performing radiochemical analyses and total activity measurements on several types of materials collected on the ANL site and from locations approximately 10, 25, and 100 miles from the Laboratory. The sampling locations are given in Part II. The average total activities in samples of water, material from the beds of lakes and streams (bottom silt), soil, and plants during 1959 are tabulated. For purposes of comparison, the results obtained from 1952 through 1959 are included. Air-filter results are also tabulated. Fallout activity was present in most samples at all locations. The amount of fall-out was relatively high during the first part of the year, but decreased markedly during the latter half. By the end of the year the shorter-lived fission products from fall-out were at the lowest level since 1955. Airborne β activity from fall-out decreased from a maximum of about 5 $\mu\mu c/m^3$ in April to less than 0.1 $\mu\mu c/m^3$ in December. The average for the year, about 2.3 $\mu\mu c/m^3$, was 25% less than for 1958, but approximately twice as high as the average from 1953 to 1957. The long-lived airborne α activity has not changed appreciably since 1953. Air-filter samples were collected both on the site and at four locations from 6 to 20 miles from the Laboratory. The activities were essentially the same both on and off the site, and no indication of activity originating at Argonne was found in the samples. (auth)

11359 (CLOR-3) PERSONNEL FILM MONITORING SERVICE IN POLAND DURING THE YEAR 1959. T. Musiatowicz, J. Pensko, J. Wysopolski, and R. Podgorski (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorxystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). July 1960. 16p.

Tables and charts present the results of regular film-monitoring service carried out for isotopic laboratories in Poland during 1959. (C.H.)

11360 (CRER-962) RADIOSTRONTIUM AND RADIOCESIUM IN OTTAWA RIVER WATER, NOVEMBER 1959–MAY 1960. J. E. Guthrie (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1960. 12p. (AECL-1092)

A preliminary survey was made of the Sr^{89}, Sr^{90}, and Cs^{137} in drinking water taken from the Ottawa River at Deep River and Pembroke, Ontario. The mean concentration of Sr^{90} during the period Nov. 1959 to May 1960 was 0.9 $\mu\mu c$/liter. The mean value obtained for Cs^{137} was 0.28 $\mu\mu c$/liter at Deep River and 0.4 $\mu\mu c$/liter at Pembroke. The Sr^{90} and Cs^{137} concentrations found in rain and snow exceed those in river water. (auth)

11361 (DP-533) DETECTION OF U^{235} BUILDUP IN SEPARATIONS PROCESSES BY NEUTRON MULTIPLICATION. Alwyn C. Lapsley (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1960. Contract AT(07-2)-1.

A neutron multiplication technique was developed to indicate the build-up of U^{235} in radiochemical separations plants. In dilute U^{235} solutions, the count rate of the monitor increased about 5% for each additional gram of U^{235} per liter. (auth)

11362 (IDO-16632) METHOD OF CALCULATING LUNG DOSE RECEIVED FROM A CONFINED CLOUD OF RADIOACTIVE GAS. D. E. Hankins and W. C. King (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 23, 1960. Contract AT(10-1)-205. 27p.

A method is described by which the results obtained on a film badge can be used to determine the dose delivered to the lungs by a radioactive gas in a confining situation. The procedure involves the resolving of an infinitely large β cloud into shells each of which delivers to the center point the same fraction of the total dose. The dose received from the β cloud contained in the confining situation can be determined as some percentage of the dose which would be delivered from an infinite cloud containing the same concentration of β activity. The film badge reading is then increased by a factor which will make it equal to the reading that would be obtained from an infinite cloud. From this adjusted film badge reading, the concentration of the radioactive gas and the resulting lung dose can be determined. (auth)

11363 (MND-P-2396) FINAL SAFETY EVALUATION OF PLUTONIUM PROCESSING TO BE PERFORMED IN THE HEAVY ELEMENT PROCESSING FACILITY. John Watcher (Martin Co. Nuclear Div., Baltimore). Sept. 1960. 61p.

The potential hazards associated with the handling and processing of Pu^{238} and Pu^{239} were evaluated. Processing operations consist of chemical purification, fuel form conversion, fabrication, and encapsulation and will be performed in the Heavy Element Processing Facility. The hazards presented by these radioisotopes are a consequence of their nuclear properties and chemical behavior. The metals are pyrophoric at elevated temperatures and fissile. The primary hazard appears to be the possibility of inhaling or ingesting the material and demands almost absolute containment during all phases of the process. It was shown that criticality is not an area of concern since the maximum quantity of the materials present within the Facility at any time is of the order of 800 g of Pu^{238} and 50 g of Pu^{239}. An over-all safety factor of 10 was estimated for Pu^{239}. During the fluorination process ~10^9 neutrons/sec will result from (α,n) reactions with fluorine, or, coupled with spontaneous fission neutrons, a dose rate of 3.5×10^3 mrem/hr at 1 meter (for a 50-g batch of Pu^{238}). Approximately 12 in. of polyethylene (or water) are required to reduce the dose rate to 10 mrem/hr. Neutron dose rates for the nitrate and oxide (50 g of Pu^{238}) were estimated at 3.2 and 20.9 mrem/hr, respectively. For the plutonium metal reduction phase, the reaction vessel and contents reach a maximum temperature of 1080°C. At this temperature the internal pressure is ~4 atm. The maximum permissible internal pressure for the reaction vessel was estimated at 136 atm, or a safety factor of 34. Fabrication and encapsulation operations will be performed in a controlled inert-gas atmosphere, i.e., the rate of gas flow and the gas moisture content are continuously monitored and corrected, when necessary, to meet specific requirements. (auth)

11364 (NDL-TR-3) GROUND PENETRATING RADIATION (LIP CONTRIBUTION) IN A FOXHOLE FROM A FALLOUT FIELD SIMULATED BY COBALT^{60}. Michael J. Schumchyk and Hans J. Tiller (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). Dec. 1960. 38p.

The lip contribution to the total radiation in a cylindrical foxhole (4 ft in diameter and 4-ft deep) from a fall-out field simulated by Cobalt^{60} has been measured and calculated. The lip contribution averaged 68% of the total dose rate received at different depth levels in the hole. Of the ground penetrating radiation 99% stems from a 2-ft-wide annulus around the foxhole, the inner circle of which is the rim of the hole. (auth)

11365 (PB-121784R) RADIOLOGICAL HEALTH HANDBOOK. (Public Health Service, Washington, D. C.). Revised Sept. 1960. 468p.

Data are compiled for the use of scientists and technicians working in the fields of atomic energy and radiological health. Physical, chemical, and mathematical data, constants and conversion factors, data on radioisotopes, decay, radioassay procedures, and radiation protection are included. A revised table of isotopes, the latest revision of the chart of the nuclides, an extensive glossary, a list of 54 basic references, and a subject index are also included. (C.H.)

11366 (TID-11740) ENVIRONMENTAL RADIATION MONITORING. Quarterly Report, Third Quarter–1960, July–August–September. (Duquesne Light Co., Shippingport, Penna.). 24p.

The decline in background radioactivity that appeared in the first quarter of this year has continued through this quarter with only one exception; there has been a slight increase in short lived airborne particulate radioactivity. The fall-out measurements are essentially the same as reported during the past year. A few high α radioactivity measurements were observed, but, as usual, these were at the sampling station that accumulates mass fall-out, making concentration determination difficult. The concentration of radioactive materials in the Ohio River appears to be unchanged and there was no significant change in river bottom mud radioactivity. It appears that algae-fixed solid activity has decreased to half of that formerly reported. (auth)

11367 (TO/HS/22) DOSIMETRIC INVESTIGATION OF THE RADIATION ACCIDENT, VINCA, YUGOSLAVIA. G. S. Hurst, R. H. Ritchie, F. W. Sanders, P. W. Reinhardt, J. A. Auxier, E. B. Wagner, A. D. Callihan, K. Z. Morgan, and J. W. Smith (International Atomic Energy Agency, Vienna). Dec. 1, 1960. 71p. (A/AC.82/G/L.513).

The radiation accident at the Boris Kidric Institute, Vinca, Yugoslavia, on Oct. 15, 1958, resulted in heavy exposure of six scientists to a mixture of neutrons and γ radiation during a subcritical experiment with a zero power re-

actor. The reactor was constructed with natural uranium rods suspended in a large tank which could be filled to various depths with heavy water. A team from the Oak Ridge National Laboratory, Tenn., made measurements of the radiation dose received by the exposed persons. The methods of dosimetry were essentially those used in connection with the Oak Ridge Y-12 accident and are based on the ratio of Na^{24} to Na^{23} in the body or blood system. To accomplish the measurements the zero power reactor was operated in two different power ranges. Data are presented from computations of γ dose leakage; studies of Na^{24} activation in man-shaped phantoms; an intercomparison of French and American Na^{24} calibration; measurements of the neutron flux distribution in the Vinca reactor room; and neutron measurements with a tissue-equivalent phantom. Individual doses were calculated as ranging from 207 to 436 rad units. Photographs and drawings are included of the equipment and experimental facilities. Results of measurements are presented graphically. (C.H.)

11368 (UCRL-6054) FRACTURING OF ROCK SALT BY A CONTAINED HIGH EXPLOSIVE. Nicholas M. Short (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 10, 1960. 60p. PROJECT COWBOY. Contract W-7405-eng-48.

On Feb. 20, 1960, 1000 lb of Pelletol high explosive was detonated in salt as part of Project Cowboy, an AEC-sponsored study of seismic decoupling of explosions. The detonation was contained in a tamped 3.0- by 4.5-ft cylinder drilled within a salt dome. In Project Plowboy, a Plowshare program for examination of explosion-induced fracturing of salt, the effects of this 1000-lb explosion were investigated by mining directly into the cavity region. The 1000-lb explosion increased the maximum diameter of the cylindrical cavity by 60% and enlarged its volume by more than two. The salt failed close-in by conspicuous plastic deformation but shows no crushing. Numerous open fractures extended into the salt for a foot from the cavity surface at a frequency of 4 to 8 fractures per sq ft. Failure beyond this inner zone was by tensional fracturing; the fractures were closed and about $^1/_{32}$ in. wide. The frequency of fractures decreased at 10 ft to around one per square yard. A few fractures extended to 20 ft or more from the cavity; one fracture was traced for 45 ft. With one exception all known fractures were carbon-filled. Several fractures clearly showed the role of cleavage in localizing failure: Elongate cleavage blocks in the fracture plane formed a lineation which trended directly toward the cavity. Anhydrite banding in the salt exercised no control on orientation or position of fractures. Away from the immediate cavity, vertical fractures radial from the cavity dominated. Two sets of low-angle fractures emanated from the cavity roof to form cones, each with apex pointing downward into the cavity. Very few fractures occurred above the cavity roof or below the cavity floor; local shearing did develop in the roof. (auth)

11369 (USNRDL-TR-466) THE DOSE DISTRIBUTION WITHIN AN AIRCRAFT CARRIER EXPOSED TO UNIFORM Co-60 CONTAMINATION ON THE FLIGHT DECK. B. W. Shumway, S. Tomoeda, G. E. Plummer, W. G. Miller, and M. B. Hastings (Naval Radiological Defense Lab., San Francisco). Oct. 4, 1960. 39p.

Experimental measurements of specific dose rate were made on six decks of a light aircraft carrier with its Flight Deck "uniformly contaminated" with Co^{60}. From the data general rules regarding dose distribution were drawn, and the effects of various structural elements were studied. Transmission factors were obtained which agreed fairly well with values computed from earlier data collected with point sources of Co^{60}. Depth-dose measurements showed the radiation to maintain its highly penetrating character. (auth)

11370 (USNRDL-TR-476) THE APPLICATION OF HIGH INTENSITY PRE-EXPOSURES TO FILM-PHOSPHOR DOSIMETRY. T. T. Mercer and R. Golden (Naval Radiological Defense Lab., San Francisco). November 8, 1960. 35p.

The fraction of all silver halide grains converted to a stable subimage by preexposures of constant duration but different intensities was determined for several films. The fraction was found to go through a maximum of about 0.12 as the preexposure intensity was increased. The experimental data throw doubt on the assumption that the conversion of stable subimage to developable latent image by a given exposure is independent of the intensity at which the exposure is made. The fading of the stable subimage with time was investigated. The relation of these findings to film-phosphor dosimetry is discussed. (auth)

11371 (WADD-TR-60-476) HUMAN FACTORS IN REMOTE HANDLING: SURVEY AND BIBLIOGRAPHY. Billy M. Crawford and D. Frederick Baker (Wright Air Development Div. Behavioral Sciences Lab., Wright-Patterson AFB, Ohio). July 1960. 35p. (AD-242524)

The state of the art in remote handling is assessed and related to present and future advanced system requirements. Principal features and purposes of the main types of remote-handling systems, including sensory feedback provisions, are described. Human engineering considerations related to equipment design, motor and sensory requirements of tasks, and perceptual difficulties, together with possible solutions, are discussed. Conclusions derived from experience and experimental studies are listed to stimulate and coordinate further research and development efforts. Possible implications of current remote-handling concepts for planning nucler-powered systems and space support units are given special consideration. A bibliography representing a thorough screening of information sources in the United States, Canada, Great Britan, and France is included. (176 references) (auth)

11372 (AEC-tr-4438) FEDERAL LAW ON THE PEACEFUL UTILIZATION OF ATOMIC ENERGY AND ON PROTECTION AGAINST RADIATIONS (DATED DECEMBER 23, 1959) OF THE SWISS FEDERAL LEGISLATURE. Translated from a publication of the Swiss Federal Legislature. 24p.

In December 1959 the Swiss Federal Legislature enacted new laws governing the peaceful utilization of atomic energy and protection against radiations. The Federal Council nominates the commissions charged with the study of problems relating to atomic energy and protection against radiations. The law covers all aspects of administration and protection. (C.H.)

11373 (CEA-tr-A-843) DOSIMÉTRIE DES RAYONS β EN PROTECTION CONTRE LES RAYONNEMENTS. (Beta-Ray Dosimetry in Radiation Protection). K. Sommermeyer and H. Opitz. Translated into French from Atomkernenergie 4: 404-8(1959). 28p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 1722.

11374 TECHNIQUES FOR CONTROL OF BERYLLIUM DUST. PARTS I, II, AND III. W. B. Harris, A. J. Breslin, and Merrill Eisenbud (U. S. Atomic Energy Commission, New York). Air Eng., 40-9(Aug. 1959).

Beryllium dust presents dust control, ventilation, and air

pollution problems. Data are presented on control methods for air engineers. (auth)

11375 ORGANIZATION OF A RADIATION HAZARD EMERGENCY RESPONSE CAPABILITY. A. J. Breslin, W. B. Harris, and A. A. Weintraub (U. S. Atomic Energy Commission, Health and Safety Lab., New York). Am. Ind. Hyg. Assoc. J., 22: 59-63(Feb. 1961).

The U. S. Atomic Energy Commission in cooperation with the Department of Defense maintains a nationwide organization of radiation safety teams to provide emergency technical assistance to state and local officials in the event that an accident with public health significance occurs during the utilization, handling, or transportation of radioactive materials. The capability to handle such accidents is not yet adequately developed at the state and municipal levels. The basic mission of the teams is to provide rapid hazard evaluation and recommendations for control. Important requirements for the satisfactory performance of this mission are effective liaison with civil authorities, expeditious team mobilization and transportation, use of professional radiation safety personnel, and field equipment suitable for rapid and approximate measurements. (auth)

11376 HEALTH AND SAFETY IN HANDLING THE NEWER METALS. William B. Harris (U. S. Atomic Energy Commission, New York). Am. J. Public Health, 49: 1138-42(Oct. 1959).

Some of the hazards involved in the use of Th, U, Zr, Ti, Be, and Pu are discussed. (D.E.B.)

11377 IN VIVO DOSIMETRY WITH MINIATURE GLASS RODS. PART I. PHYSICAL ASPECTS AND RECENT DEVELOPMENTS. Stanley J. Malsky, Charles G. Amato, Cyprian B. Reid, Charles Spreckels, and L. Maddalone (Veterans Administration Hospital, Bronx, N. Y.). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 568-71 (Mar. 1961).

The radiophotoluminescent glass dosimeter can be employed to measure radiation within the human system and a relative calibration system can be obtained for standard techniques of calibration. Although the dosimeter is energy dependent for various photon energies, this factor can be eliminated in part for a specific photon range by the use of a suitable shield. The use of a low Z composition glass makes possible a reduction in the wall thickness of the gold employed in the shield material. The glass dosimeter can be used in vivo to obtain a γ ray spectrum with the aid of accepted techniques of absorption spectroscopy. However, machine calculations are necessary due to the mathematical analysis required. The glass dosimeter can be used, with a suitable lithium shield, for the measurement of γ rays in the presence of intense neutrons. The glass is being investigated for possible use in a neutron spectrometer. The bare dosimeter is being investigated for total and partial absorption of various energy β rays. (auth)

11378 IN VIVO DOSIMETRY WITH GOLD-SHEATHED MINIATURE GLASS RODS. PART II. CLINICAL APPLICATIONS IN RADIATION THERAPY. Bernard Roswit (Veterans Administration Hospital, Bronx, N. Y.). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 572-82 (Mar. 1961).

The development is described of a practicable and reliable microdosimeter system for accurate in vivo human dosimetry in radiation therapy. This system is immediately adaptable to routine clinical use and experimental studies. It has been employed successfully in nearly all body tissues and spaces in cancer patients receiving ionizing radiation. The detectors consist of tiny photoluminescent glass cylinders enclosed in miniature gold cartridges which can be easily and quickly fabricated. (auth)

11379 PROTON RADIATION HAZARDS IN SPACE. Hermann J. Schaefer (U. S. School of Aviation Medicine, Pensacola, Fla.). Astronautics, 6: No. 2, 39; 62; 64; 66; 68(Feb. 1961).

Proton radiation in space will come from both the Van Allen Belt and solar flares. Although the transitory radiation fluxes from these flares contain a variety of particles, the proton component is chiefly responsible for radiation effects on man. Observations of proton flux after the solar flares of May 10, 1959, and February 23, 1956, were studied to determine the basic differences in depth-dose pattern as compared to the proton beam in the inner Van Allen Belt. Absolute and normalized depth-dose rates were determined for a spherical tissue target 52 cm in diameter (75 kg). Mean and instantaneous relative biological effectiveness were calculated for the radiation fields. The most suitable shielding would be material of low atomic number, which would have the additional advantage of also affording optimal protection against electrons. (M.C.G.)

11380 THE COVERING OF FLOORS AND WALLS IN HIGH ACTIVITY LABORATORIES. F. Dubois and C. Vinit. Bull. inform. sci. et tech. (Paris), No. 44, 45-58(Oct. 1960). (In French)

Anticorrosion coverings obtained by painting are described. The different types of paints, their advantages, and disadvantages are discussed. The quality control and test methods are reviewed. A comparative tabulation of the chemical tests on different types of paints is presented. The covering of floors by plastic films is also discussed. (J.S.R.)

11381 EVOLUTION OF THE VENTILATION CHARACTERISTICS OF HIGH ACTIVITY LABORATORIES. R. Sallé. Bull. inform. sci. et tech. (Paris), No. 44, 59-65(Oct. 1960). (In French)

The ventilation system of hot laboratories has the task of limiting the concentration of active materials in the atmosphere, of confining any eventual contamination, and of retaining dangerous dusts before disposal to the air. The evolution of the general characteristics of the system is briefly reviewed. The improvements made are described in some detail, and the filters used in the system are discussed. (J.S.R.)

11382 MEASUREMENT AND DISCRIMINATION OF THE RADIOACTIVITY OF LUMINOUS DIALS. GONAD DOSE. G. Joyet (Zurich, Switzerland). Helv. Phys. Acta, 33: 557-60(1960). (In French)

The radioactivity of 250 luminous dials of wrist watches and 80 luminous dials of alarm clocks was measured and analyzed for both the γ and β radiation. Some typical results are tabulated. It was found that 94% of the watches were activated with pure radium, 1.6% with a mixture of strontium and radium and 2% with pure $Sr^{90} + Y^{90}$. The ratio between the activity of the watch and the annual dose of radiation received by the gonads was determined. The genetic dose per generation is then determined. A value of 100 mr or 3.3 mr per year was found for the genetic dose per generation for wrist watches and 0.4 mr per year for alarm clocks with luminous dials. (J.S.R.)

11383 CERTAIN PROBLEMS OF HYGIENIC STANDARDIZATION OF MAXIMUM PERMISSIBLE DOSES OF IONIZING RADIATION. A. N. Marei. Med. Radiol., 5: No. 11, 3-7(Nov. 1960). (In Russian)

Problems of radiation dose standardization are discussed

from the hygienic viewpoint. A brief hygienic assessment is given of the existing international standards, and these problems are brought to the attention of Soviet hygienists working in this field. (auth)

11384 PROTECTIVE COATING ON BUILDING DESIGNS AND MEANS OF THEIR INACTIVATION OF RADIOACTIVE POLLUTION. S. M. Gorodinskiĭ, L. M. Nosova, and Z. E. Panfilova. Med. Radiol., 5: 57-61(Nov. 1960). (In Russian)

Problems of inactivation of premises and equipment of laboratories in their pollution with radioactive substances are discussed. Personal experience and literature data are given. (auth)

11385 ANALYSIS OF SCINTILLATION SPECTROMETER OBSERVATIONS OF Co^{60} AND Na^{24} GAMMA RADIATION THROUGH CADMIUM. K. A. Mahmoud (Univ. of Cairo and Atomic Energy Establishment, Cairo) and M. S. El-Nesr. Radiation Research, 14: 17-22(Jan. 1961).

The spectrum of γ rays from point isotropic sources was computed experimentally for Co^{60} and Na^{24} of average and primary energies of 1.25 and 2.76 Mev, respectively. The experimental curves selected were chosen in such a way that they would cover a thickness of cadmium suitable in nuclear plants. For that reason the thicknesses of cadmium were about the same for the different γ-ray energies, but the mean free paths were eventually varying. (auth)

11386 RADIATION PROTECTION CRITERIA AND STANDARDS; THEIR BASIS AND USE. HEARINGS BEFORE THE SPECIAL SUBCOMMITTEE ON RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SIXTH CONGRESS, SECOND SESSION, MAY 24, 25, 26, 31, JUNE 1, 2, AND 3, 1960. (United States. Congress. Joint Committee on Atomic Energy). 1960. 825p.

During May and June 1960, the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy held 7 days of public hearings on Radiation Protection Criteria and Standards: Their Basis and Use. It was the intent of these hearings to emphasize concepts and understanding of subject matter from a broad point of view rather than the strictly technical aspects. Emphasis was also placed on the organizational and administrative aspects of radiation protection in the Government. Of specific interest was the question of who develops radiation protection criteria and standards and for what purposes. Also of specific interest was the question of who adopts basic exposure dose recommendations for actual applications in atomic energy activities, whether the Government itself or under license or other control. The fundamental importance of establishing realistic and workable radiation protection standards in the federal program is emphasized. Data are appended on radiation protection criteria and standards in effect in 1960. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

11387 (ARF-1150-6) DESIGN STUDIES ON CESIUM-137 AS A SOURCE FOR HIGH LEVEL GAMMA IRRADIATIONS. Quarterly Progress Report No. 2 Covering the Period from Sept. 1, 1959 to Dec. 1, 1959. L. Voyvodic (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 29, 1960. 8p. Contract AT(11-1)-779.

Further studies are reported on the analytical behavior and experimental testing of Cs^{137} plaque irradiator designs. Low-level sources used for the initial experiments consisted of about 7 mc of Cs^{137} aqueous solution in brass trays 20 by 20 by $\frac{1}{2}$ in. high having wall thicknesses of $\frac{1}{16}$ in. Calibration tests were made preliminary to radiation field mapping. (T.R.H.)

11388 (NYO-2503) THE TECHNOLOGY AND APPLICATIONS OF LARGE FISSION PRODUCT BETA SOURCES. Joseph Silverman, Jacques J. Weinstock, Horace W. Chandler, and Ernest J. Henley (Radiation Applications Inc., Long Island City, N. Y.). Jan. 1, 1961. 110p. Contract AT(30-1)-2186.

An analysis of radiation processing shows promising areas for commercial application of large quantities of fission-product β emitters, particularly in the graft copolymerization modification of formed plastic surfaces and textiles. Massive, rugged, inert, safe, inexpensive β sources can be fabricated by suitable extensions of existing techniques. Thin source-bearing glass coatings on metal sheet or wire-mesh backings show particular promise. Beta-absorption calculations based on a semiempirical point source function indicate that extended β sources can be designed with β-utilization efficiencies as high as 35%. Equations and curves describing dose and β-utilization efficiency as a function of the geometry and composition of various source-target systems are presented. An engineering cost analysis indicates that fission-product β power can compete with alternative sources of radiation. (auth)

11389 (NYO-2504) THE TECHNOLOGY AND APPLICATIONS OF LARGE FISSION PRODUCT BETA SOURCES. Quarterly Report for the Period October 1 to December 31, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Feb. 7, 1961. 28p. Contract AT(30-1)-2186.

Cerium frit was prepared to study the effect of milling conditions on particle size distribution of the powdered frit. No appreciable effect was found in addition of small amounts of chloride on the leachability of cerium frit. Sources of Pm^{147} and Ce^{144} were prepared, and some dosimetry studies were conducted. Techniques were developed for preparing pellets of fused frit for leach tests. A study was conducted of the radiation-induced grafting of styrene-methacrylic acid to polypropylene in the monomer-wetted (as opposed to the monomer-immersed) polymer system. A preliminary engineering design and cost estimate are included for a pilot-scale β irradiator to be used in the graft polymerization. (auth)

11390 (TID-11169) ISOTOPIC METHOD FOR AGE DETERMINATIONS OF INDUSTRIAL PRODUCTS. Quarterly Progress Report, July-September 1960. T. C. Gregson (Goodyear Tire and Rubber Co., Akron, Ohio). Contract AT(11-1)-719.

Progress is reported on gasoline and tire dating. The procedure and apparatus used in synthesizing alkyl halides from aliphatic alcohols are included. (W.L.H.)

11391 (TID-11347) STUDY OF THE INDUSTRIAL POTENTIAL OF RADIOISOTOPIC METHODS IN THE SYNTHETIC DETERGENT AND SOAP INDUSTRY. Quarterly Progress Report No. 1, March 1–May 29, 1959. Charles W. Stanley (Midwest Research Inst., Kansas City, Mo.). June 3, 1959. 6p.

Results are reported from a survey of the soap and synthetic detergent manufacturing industry to determine the potential for applying radioisotope techniques to research, development, and manufacturing problems. As a result of an extensive literature search and visits to several manufacturing facilities, it was learned that present uses of radioisotopes have been mainly in research with some plant process-control applications. Research and process-control uses are outlined. Several possible applications for new radioisotope techniques are suggested. (C.H.)

11392 (TID-11348) STUDY OF THE INDUSTRIAL POTENTIAL OF RADIOISOTOPIC METHODS IN THE SYNTHETIC DETERGENT AND SOAP INDUSTRY. Quarterly Progress Report No. 2, June 1–August 31, 1959. Charles W. Stanley (Midwest Research Inst., Kansas City, Mo.). Aug. 31, 1959. 27p.

Results are reported from a survey of the soap and synthetic detergent manufacturing industry to determine the potential for applying radioisotope techniques to research, development, and manufacturing problems. Present uses and possible future applications were surveyed. Details of the soap and synthetic detergent manufacturing processes are reviewed. Possible applications of radioisotope techniques for the industry are suggested. 22 references. (For preceding period, see Report TID-11347.) (C.H.)

11393 (AEC-tr-4410) RADIOTRACER METHOD FOR THE STUDY OF THE WORKING PROPERTIES OF LUBRICATING OILS. Yu. S. Zaslavskiĭ and G. I. Shor. Translated from Report No. RICC/305 presented at the Conference of the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 20p.

The creation of high-quality oils with additives for modern motors, machines, and mechanisms depends largely on the availability of effective laboratory methods for the investigation and evaluation of their properties. Radioactive tracer methods were developed for investigating the operating properties of oils with additives and reflecting the mechanism of action of the additives. Applications are described in investigations of the dispersive properties of oils with additives; investigations of the lubricating properties of oils with additives; evaluation of the chemical activity of antiscorch additives; and the evaluation of the neutralizing properties of oil additives. (C.H.)

11394 APPLICATION OF RADIOISOTOPES IN ABRASION RESEARCH. József Fodor, Gábor Keömley, and Lajos Maróti. Energia és Atomtech., 13: 563-70(Dec. 1960). (In Hungarian)

Abrasion and wear studies are of great importance in developing nondestructive testing methods for motor vehicles. Previously used weight loss and dimensional change measurements require extensive testing periods in order to obtain reproducible data because the wearing process involves very small amounts of materials. Introduction of a radioisotope into the component to be tested increases the precision and reduces the time required for the testing because the portion removed from the metal and transferred into the oil or elsewhere can be easily detected. The radioactive isotope may be used as an alloying addition or as a galvanic plating, or it may be inserted into specially drilled holes. The activity of the abraded parts may be determined by counters or by autoradiography. Work is in progress on the wearing parameter of bearings, using radioactive tin. (TTT)

11395 DETERMINATION OF THE RATE OF CRYSTALLIZATION OF STEELS BY MEANS OF RADIOISOTOPES. **József** Fodor and **J**ózsef Tibor (Radioisotope Lab. of the Csepel Iron and Metal Works, [Budapest]). Energia és Atomtech., 13: 571-3(Dec. 1960). (In Hungarian)

A method was developed for determining the crystallization rate of steels using Cr^{51} instead of the usually employed Fe^{59}, thus eliminating the problems arising from the scattering of the hard gamma radiation of the latter isotope. The energy of the gamma radiation of Cr^{51} is only 0.32 Mev, which is small enough so that its scattering does not interfere with determination of the local activity levels by autoradiography or other means. Results of the tests indicate that the solidification of cast-steel specimens takes place in an asymmetric manner. This is probably caused by the uneven flow of the liquid metal resulting in a nonuniform cooling. (TTT)

11396 A RADIOISOTOPE PROPULSION SYSTEM. W. Short and C. Sabin (Convair, San Diego, Calif.). J. Brit. Interplanet. Soc., 17: 453-8(Nov.-Dec. 1960).

A propulsion device is studied theoretically which utilizes directly the alpha particles emitted by a radioactive isotope as the exhaust gas. The random direction of emission and the absorption of the decay particles in the solid is considered in the analysis. It is found that 11.8 mg of Th^{228} deposited per square centimeter of alpha-absorbing surface will produce 0.0039 dyne of thrust. The application of this system to space propulsion, to attitude control, and to extending satellite lifetimes is discussed. (auth)

11397 NON-DESTRUCTIVE METHOD OF DETECTION OF ROTTEN STATE IN STANDING TREES AND WOOD MATERIALS UTILIZING RADIOACTIVE ISOTOPES. Saburo Sakamoto and Noriyoshi Iizuka. Mem. Fac. Eng. Hokkaido Univ., 10: 117-27(Sept. 1956).

The γ rays of Co^{60} were used in the detection of the rotten state in standing trees and wood materials in the following manner: The Co^{60} source and detector were placed on opposite sides of the tree in various positions from edge to edge and a curve of the counting rate as a function of position was drawn. The deviation of this curve from the curve calculated from the γ absorption per unit distance in the tree gave a measure of the rotten state of the tree. The effects of wood nodes and water on the counting rate were studied. Field runs were made on 34 standing fir trees; high hitting percentages were obtained, the lowest being 75%. (D.L.C.)

11398 THE DEVELOPMENT OF RADIATION PROCESS APPLICATIONS. S. H. Pinner (BX Plastics Ltd., Essex, Eng.) and W. H. T. Davison. Nuclear Instr. & Methods, 11: 227-37(Jan. 1961). (In English)

The patent literature provides a measure of applications for radiation processes. At present there are well over 200 U.K. and U.S. patents that can be classified into (a) polymerization: (b) crosslinking of polymers; (c) degradation of polymers; (d) multicomponent polymers (graft and block copolymers); (e) general chemical reactions and petroleum products; (f) sterilization; (g) specific articles and shapes; (h) uses for irradiated polymers; (i) inorganic compounds; and (j) machines for generating radiation (including isotopes). Processes involving polymers account for more than 75% of these patents; so it can be fairly claimed that the major application of radiation will lie in the polymer field. The first polymerization patent was granted in 1927 and the first crosslinking patent in 1933, but the first patent on multicomponent polymers was only granted in 1958 and this is the topic selected for detailed consideration. The development of multicomponent polymers can be classified into (a) direct grafting; (b) indirect grafting; (c) peroxidation grafting; (d) block copolymers; and (e) attenuated network polymers. These methods are outlined and exemplified, by reference to continuous process techniques. More recently, the application of radiation processes to polyvinyl chloride has attracted interest. This can be converted into infusible and insoluble rigid sheet with potential use as a solvent-resistant and corrosion-resistant structural material, by incorporating a plasticizer containing two or more olefinic double bonds and subjecting to radiation. The plasticizer is caused to polymerize and form a network which is attenuated by the polyvinyl chloride molecular chains. The drawback to this material is its brittleness, but recent work has shown this can be overcome by incorporating a small amount of a

saturated elastomer. By inference, well-crosslinked materials are not necessarily brittle and this widens the scope for attenuated network copolymers in industrial applications. (auth)

11399 IMPROVEMENTS IN IRRADIATION OF NYLON. (to General Electric Co.). British Patent 860,280. Feb. 1, 1961.

A method of preparing nylon having reduced susceptibility to oxidation and reduced elongation is outlined which consists of irradiation and annealing treatments. The irradiation is performed with ionizing radiation of energy ≥ 50 kev to a dose of 10^6 to 10^8 rep at a temperature below 100°C, and annealing is carried out immediately after irradiation at from 100 to 225°C, or just below the melting point of the polymer. The annealing treatment removes the crystallinity that would otherwise trap free radicals and thus make the polymer susceptible to oxidation. (D.L.C.)

11400 SOLID POLYMERS CONTAINING INORGANIC MATERIALS. (to Esso Research and Engineering Co.). British Patent 860,316. Feb. 1, 1961.

A process is outlined for producing a solid rubbery polymer containing a solid inorganic material. This polymer is suitable for use as solid propellant fuel for rockets and as a shock absorbing material, e.g., impact cushions on automobile dashboards. The polymer is made from a mixture of a diene polymer or copolymer, an organic polyhydrosulfide, and an inorganic oxidizing or inactive salt. Radiation is used to cure the mixture, which is of advantage for solid propellant fuels since irradiation causes the mixture to bond to the casing metal. (D.L.C.)

11401 PREPARATION OF GRAFT CO-POLYMERS. (to Midland Silicones, Ltd.). British Patent 860,327. Feb. 1, 1961.

A process is given for preparing graft copolymers of siloxane polymers. In this process, the siloxane polymer is exposed to ionizing radiation in absence of oxygen diffusion at a temperature below that of the second transition, brought into contact with the grafting material, and allowed to warm up (whereupon grafting occurs). (D.L.C.)

11402 IMPROVED COMPOSITIONS CONTAINING POLYETHYLENE. (to Minnesota Mining and Mfg. Co.). British Patent 860,344. Feb. 1, 1961.

A method is given for producing heat-resistant polyethylene compositions. In this method, a mixture containing at least 70 wt.% polyethylene and a thermal degradation inhibitor is subjected to high-energy ionizing radiation. The inhibitor is a mixture of chlorinated resin or a butadiene-styrene copolymer with an antioxidant and carbon black. (D.L.C.)

11403 IMPROVEMENTS IN OR RELATING TO A PROCESS FOR THE MANUFACTURE OF GRAFTED VINYL POLYMERS. (to Compagnie de Saint-Gobain). British Patent 860,347. Feb. 1, 1961.

A simple method is given for increasing the grafting values of vinyl polymers (especially polyvinyl chloride) which undergo radioinduced graft copolymerization. This method consists of subjecting the grafted polymer to further grafting operations, since the grafted polymer is still capable of absorbing a fresh quantity of vinyl monomer, although a longer time of contact is required. For example, a polymer of vinyl chloride grafted in a first operation to a grafting value of 33% with acrylonitrile can, by successive operations, reach a value of 200% and higher. (D.L.C.)

11404 IMPROVEMENTS IN OR RELATING TO A PROCESS FOR THE PRODUCTION OF POLYVINYL CHLORIDE/POLYMER MIXTURES AND THE PRODUCTS OBTAINED BY THIS PROCESS. (to Compagnie de Saint-Gobain). British Patent 860,348. Feb. 1, 1961.

A process is given for preparing homogeneous mixtures of polyvinyl chloride with polymers which are normally incompatible with polyvinyl chloride. The process consists of grafting the monomer of the polymer which is to be incorporated, on polyvinyl chloride with radiation and then mixing the grafted polyvinyl chloride with the polymer. For example, for the preparation of a homogeneous mixture of polyvinyl chloride and polyacrylonitrile, polyvinyl chloride is swelled with acrylonitrile, irradiated to effect grafting, and then simply mixed with polyacrylonitrile. (D.L.C.)

ISOTOPE SEPARATION

11405 (TID-5230) DEVELOPMENTS IN THE CENTRIFUGE SEPARATION PROJECT. J. W. Beams (Virginia. Univ., Charlottesville), A. C. Hagg (Westinghouse Electric Corp., Pittsburgh), and E. V. Murphree (Standard Oil Development Co., Elizabeth, N. J.). 1951. Decl. Oct. 29, 1959. 269p. (NNES-X-1)

The development programs undertaken to devise a gas-centrifuge process for concentration of U^{235} in UF_6 are described. The theory of spearation using cascades of identical countercurrent units is summarized. Early work done at the University of Virginia is reported in detail. The 42- and 132-in. centrifuges developed at Westinghouse are described, and their operation is reviewed. (T.R.H.)

11406 (TID-6102) SEPARATION OF TRITIUM FROM HYDROGEN BY THERMAL DIFFUSION. E. S. Robinson, A. C. Briesmeister, B. B. McInteer, and R. M. Potter (Los Alamos Scientific Lab., N. Mex.). 1955. Decl. June 9, 1960. 20p. (RICC/215)

Procedures and equipment are described for the separation of tritium from hydrogen by thermal diffusion. The method has been used for the production of research quantities of tritium. The tritium is produced in nuclear reactors by the reaction $_3Li^6 + {}_0n^1 = {}_2He^4 + {}_1H^3$ + energy. The hydrogen isotopes are adsorbed on activated charcoal, and the purified gas is fed to a thermal-diffusion column for the separation of hydrogen from tritium. (C.H.)

11407 (AEC-tr-4431) NEW RESULTS IN THE ISOTOPE SEPARATION OF HEAVY GASES IN THE GAS ULTRACENTRIFUGE. G. Hertz and E. Nann. Translated by Kurt H. Quasebarth from Z. Elektrochem., 58: 612-16(1954). 14p.

Issued by Univ. of Virginia Research Labs. for Engineering Sciences, as report EP-4422-120-61U.

Isotope separation experiments with xenon in the gas centrifuge gave the result that the fractions withdrawn from one rotor end are enriched in the heavy isotope, and fractions taken from the other end are enriched in the light isotope, regardless of whether the samples were taken from the axis or the edge. It has to be assumed as highly possible that the end at which the heavy gas occurs is warmer than the other. The cause of this phenomenon is assumed to be the occurrence of counter current circulation. The stability of the circulation is so great that it is possible to operate continuously and to reach separation effects of 4 to 5½ times the theoretical elementary separation. (auth)

11408 (CEA-tr-A-732) PROCÉDÉ RELATIF A L'ENRICHISSEMENT DU DEUTÉRIUM. (Process Related to Enrichment of Deuterium.) K. Diebner. Translated into French from German Patent 1,057,585. 5p.

A modification of the exchange-electrolysis process for enrichment of deuterium in water is offered. The deuterium is preconcentrated in an isotope trap in the form of

HF or CH_4, for example. Then the compound is burned or reacted appropriately to produce water containing the deuterium. The water is then electrolyzed for further concentration. (T.R.H.)

11409 (CEA-tr-A-795) DISPOSITIF DE SÉPARATION D'ISOTOPES À L'AIDE D'UNE TRAPPE À ISOTOPES FONCTIONNANT EN PHASE GAZEUSE. (Apparatus for Separation of Isotopes Using an Isotope Trap Operating in the Gas Phase.) K. Diebner. Translated into French from German Patent 1,058,024. May 27, 1959. 9p.

An isotope separator is described for gas-phase operation. A jet of the gaseous isotope mixture is directed radially outward from the center of a series of rotating and fixed screens. The first screens atomize the material. Then as the particles move outward the lighter components move to the front and are chopped off in the second set of screens. Thus a discontinuous jet of enriched material is produced for condensation on the refrigerated outer collector, the heavier fraction being condensed at the second set of screens. (T.R.H.)

11410 (CEA-tr-A-798) PROCÉDÉ DE PRÉPARATION D'EAU OU D'HYDROGÈNE ENRICHIS EN DEUTÉRIUM. (Process for Preparation of Water or Hydrogen Enriched in Deuterium.) E. W. A. Becker. Translated into French by R. Carbonnier from German Patent 1,052,960. (Addendum to German Patent 1,003,698). Mar. 19, 1959. 6p.

An improvement in the catalytic dual-temperature process for D enrichment is offered. The improvement involves use of a platinum, platinum metal, or nickel catalyst in a suspension or sol. in the water. The catalyst is then regenerated by ion exchange. This compensates for the high-temperature effects on the catalyst in earlier described processes. (T.R.H.)

11411 (CEA-tr-A-831) PROCEDE DE CONCENTRATION DE L'HYDROGENE LOURD. (Process for Concentration of Heavy Hydrogen.) R. Manteufel. Translated into French from German Patent No. 1066187 (D 28454 IVa/12i). 11p.

A distillation-exchange process for hydrogen isotope separation is offered. First runnings from a liquid hydrogen distillation, depleted in deuterium are contacted with a deuterium-containing compound at 100 to 800°C with catalyst. A part of the exchange-enriched stream goes to the distillation column, whereas the other part undergoes another exchange with the deuterium-containing compound at 0 to 100°C with a catalyst. (T.R.H.)

11412 (CEA-tr-A-857) LA SEPARATION DES ISOTOPES. (The Separation of Isotopes.) E. W. Becker. Translated into French by B. Moreau from Kerntechnik 227-61(1958). 91p.

A review is presented of isotope separation in connection with nuclear energy. The discussion includes electromagnetic, chemical exchange, distillation, diffusion, gravity, and electrolytic or electromigration methods. 76 references. (T.R.H.)

11413 (CEA-tr-R-1018) THERMOCHIMIE DES ISOTOPES. I. EXAMEN CALORIMETRIQUE DES CHALEURS DE FORMATION DE L'HYDROGENE SULFURE ET DU DEUTERIUM SULFURE. (Thermochemistry of Isotopes. I. Calorimetric Study of Heat of Formation of Hydrogen Sulfide and Deuterium Sulfide.) A. F. Kapustinskii (Kapoustinsky) and R. T. Kanovskii (Kankovsky). Translated into French from Zhur. Fiz. Khim., 32: 2810-16(1958). 17p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 5315.

11414 HEAVY-WATER PLANT MELDS NEW FEATURES. N. P. Chopey. Chem. Eng., 68: No. 4, 118-21 (Feb. 20, 1961).

A three-step process for production of D_2O is described as developed by Sulzer Bros., Ltd., Switzerland. First, natural water is electrolyzed; the deuterium-rich hydrogen stream is rectified at low temperature; finally deuterium-rich material from this step is oxidized, and the water is distilled to 99.8% D_2O. The electrolyzers operate in conjunction with an ammonia plant. Both rectification steps are carried out in one Kuhn column. A flowsheet is given. (T.R.H.)

11415 ISOTOPE SEPARATION BY REVERSIBLE CHEMICAL PROCESSES. E. Glueckauf. Endeavour, 20: No. 77, 42-50(Jan. 1961).

A survey of the field of chemical isotope separation is presented. The various methods described and discussed include distillation, exchange distillation, chemical exchange (gas-liquid), chemical exchange (liquid-liquid), dual-temperature chemical exchange, and chromatographic. (T.R.H.)

11416 KINETICS OF THE DEUTERIUM EXCHANGE BETWEEN DIBORANE AND DIMETHYLAMINODIBORANE. J. S. Rigden and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 83: 552-5(Feb. 5, 1961).

The kinetics of the deuterium exchange between diborane and dimethylaminodiborane (DMADB) were studied. The course of the reaction was followed by means of gas density measurements. The concentrations of both reactants were varied over a 20-fold range in order to establish the orders of the reaction. The reaction was found to be first order with respect to DMADB and half order with respect to diborane. The activation energy was found to be 27.8 ± 3 kcal. By variation of the surface-to-volume ratio it was determined that, to with experimental error, the reaction is homogeneous. A mechanism is proposed in which the rate-determining step is the reaction between the intermediate BH_3 and DMADB. The rather high activation energy is consistent with a postulated symmetrical intermediate in the rate-determining step. (auth)

11417 TEMPERATURE DEPENDENCE OF THE ISOTOPIC FRACTIONATION OF NITROGEN IN THE NO–NO_3^- [NO_3^-] SYSTEM. Marvin J. Stern, Lois Nash Kauder, and W. Spindel (Rutgers State Univ., Newark, N. J.). J. Chem. Phys., 34: 333-4(Jan. 1961).

The fractionation factor was measured at several temperatures (25 to 70°C) for the reaction $N^{15}O + N^{14}O_3^- \rightleftharpoons N^{14}O + N^{15}O_3^-$ by equilibrating NO gas with liquid phases consisting either of 0.98M HNO_3 or of 4.5M $Ca(NO_3)_2$, NO having negligible solubility in the latter phase. The results agree reasonably well with those calculated from spectroscopic data but are considerably higher than those reported by Brown and Begun, especially at the higher temperatures. (D.L.C.)

11418 TRITIUM SEPARATION FACTOR OF SLOW DISCHARGE MECHANISM OF HYDROGEN ELECTRODE REACTION. Takuro Kodera and Takashi Saito (Hokkaido Univ., Sapporo, Japan). J. Research Inst. Catalysis, Hokkaido Univ., 7: 5-9(Sept. 1959). (In English)

The H^3 electrolytic separation factor was calculated on the basis of the slow discharge mechanism. The results of Keii and Kodera, which showed that the slow discharge mechanism is unsatisfactory for explaining the observed values for the deuterium separation factor, were confirmed. The H^3 separation factor was calculated from the tritium critical complex, the partition function of a single HTO molecule in a unit volume of gas, and the equilibrium con-

stant of the exchange reaction. The calculated values of separation factor were found to depend strongly on the electrochemical mechanisms but were only slightly affected by different choices of potential functions. (M.C.G.)

11419 ISOTOPIC SEPARATION FACTOR OF SLOW DISCHARGE MECHANISM OF HYDROGEN ELECTRODE REACTION. II. Takuro Kodera (Hokkaido Univ., Sapporo, Japan). J. Research Inst. Catalysis, Hokkaido Univ., 7: 75-6(Sept. 1959). (In English)

The electrolytic separation factor of deuterium was calculated on the basis of the slow discharge mechanism assuming that the proton or deuteron is discharged from the water molecule as $H_2O + e \rightarrow H + OH^-$ or $DHO + e \rightarrow D + OH^-$. The results were in agreement with those obtained assuming that the proton or deuteron discharged was that of the hydroxyl ion. (M.C.G.)

11420 ON THE PREPARATION OF ISOTOPICALLY PURE LIGHT HYDROGEN. Koshiro Miyahara and Takao Kwan (Hokkaido Univ., Sapporo, Japan). J. Research Inst. Catalysis, Hokkaido Univ., 7: 77-8(Sept. 1959). (In English)

An attempt was made to investigate the isolation of the light component from ordinary hydrogen by means of chromatographic techniques. Mass spectromotive techniques showed that light hydrogen could be perfectly freed from deuterium, within ±0.0005 at.%, by chromatography. (M.C.G.)

11421 IMPROVEMENTS IN OR RELATING TO SEPARATION OF GASES OR VAPOURS BY DIFFUSION. Franz Eugen Simon, Henry Shull Arms, and Rudolf Ernst Peierls (to United Kingdom Atomic Energy Authority). British Patent 861,115. Feb. 15, 1961.

A method of separating gaseous or vaporous mixtures by diffusion is given in which the mixture is confined in the form of a sheet. The sheet is formed by passing between a pair of porous partitions, and the sheet thickness such that the coefficient of reduction of separation efficiency is $\geq \frac{1}{2}$ and that the flow is chiefly laminar. (D.L.C.)

MATHEMATICS AND COMPUTERS

11422 (BNL-622) CALCULATION METHOD FOR HETEROGENEOUS SYSTEMS. J. Chernick (Brookhaven National Lab., Upton, N. Y.). Aug. 1960. 36p.

A review of calculational methods for heterogeneous reactor systems is presented. It includes neutron age, thermal diffusion length, multiplication factor, fast fission factor, resonance capture, and thermal utilization. It omits epithermal neutron absorption, source-sink theory, and multigroup methods. (31 references)

11423 (CF-60-12-47) USE OF CONVERGENT AND ASYMPTOTIC SERIES FOR COMPUTATION OF THE MODIFIED BESSEL FUNCTION OF THE FIRST KIND. L. L. Bumgarner (Oak Ridge National Lab., Tenn.). Dec 12, 1960. 12p.

For the choice between the convergent and asymptotic series for computing $I_n(x)$, the basis for selecting the asymptotic series for all cases in which $x \geq \max(10, 1/8\ n^2)$ is shown. When x greatly exceeds the right-hand side of this inequality, the labor saved with the asymptotic series is quite considerable. On the other hand, if the inequality is not satisfied, the convergent series is recommended, as the asymptotic series may not yield meaningful results. (auth)

11424 (CF-61-1-71) A USEFUL SOLUTION FOR SHORT CYLINDRICAL SHELLS AND OTHER APPLICATIONS. S. E. Moore (Oak Ridge National Lab., Tenn.). Feb. 14, 1961. 27p.

The general solution to the basic differential equation $d^4 v/dy^4 + 4w = -4f(y)$ is transformed from the primary form treated in most texts to an alternate form in which each integration constant corresponds to one edge condition at $y = 0$. The relationships between the integration constants of the two forms are derived and the values for the transformed functions are tabulated. The particular solution is derived in general and given in unique form for various functional forms of f(y). Matrix notation is used throughout the derivations; however, a knowledge of matrix theory is not needed for application of the results. (auth)

11425 (CF-61-1-76) THOROBRED – AN IBM-704 CODE FOR STEADY STATE NUCLEAR AND ECONOMIC CALCULATIONS OF TWO-REGION HOMOGENEOUS REACTORS. S. Jaye and T. B. Fowler (Oak Ridge National Lab., Tenn.). Jan. 17, 1961. 37p.

THOROBRED is an IBM-704 code for the calculation of nuclear and economic characteristics of two-region homogeneous reactors operating on a uranium-thorium fuel cycle in the steady state. The major input variables are reactor dimensions, power level, thorium concentration, chemical and purification systems cycle times, corrosion rates, fraction of protactinium loss, and nuclear and economic data. The output includes equilibrium isotope concentrations, neutron balance, and a breakdown of fuel cost. Running times are normally less than 1 min per case. A list of the 140 input parameters and a sample problem with its solution are included. (auth)

11426 (CF-61-1-89) MULTI-TEMPERATURE CROSS SECTION TAPE FOR THE GNU MULTIGROUP CALCULATION. D. R. Vondy and C. W. Nestor, Jr. (Oak Ridge National Lab., Tenn.). Jan. 25, 1961. 14p.

A cross-section tape was prepared containing data for elements of most interest for aqueous homogeneous reactor multigroup diffusion calculations involving combinations of 150, 200, 240, 260, and 280°C temperatures. This tape permits multigroup analysis of a reactor in which two or more regions are at different temperatures. (auth)

11427 (CF-61-2-27) ON THE TRANSLATION OF BOOLEAN EXPRESSIONS. A. A. Grau and H. H. Bottenbruch (Oak Ridge National Lab., Tenn.). Feb. 9, 1961. 11p.

A computer program which translates an algebraic language like Algol into the language of the computer must analyze, optimize, and synthesize. The possibility for optimization which exists in the case of Boolean expressions is considered. (T.R.H.)

11428 (CRT-935) RACAH ALGEBRA AND THE CONTRACTION OF GROUPS. W. T. Sharp (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1960. 407p. (AECL-1098)

Racah algebra is developed systematically for a group that is compact (or finite), quasi-ambivalent, and multiplicity-free. The problems involved in extending this theory to the locally compact case are discussed qualitatively, and the case of the Euclidean group in two dimensions is treated in detail with applications to Bessel functions. The Racah algebra of a Lie group is formulated in terms of the Lie algebra. The contraction concept of Inonu and Wigner is reviewed and reformulated. It is shown that a group obtained by contraction is necessarily a semidirect product. The theory of contraction is illustrated by a systematic study of the contraction of the three-dimensional Lie algebras. The simple groups that have the Lorentz group as contraction are determined. The effect of con-

traction on Racah algebra is studied for the case of the rotation group in three dimensions. (auth)

11429 (DOFL-TR-853) PROBABILITY DISTRIBUTIONS USING A COUNTING SYSTEM WITH A FINITE RESOLVING TIME. Arthur Hausner (Diamond Ordnance Fuze Labs., Washington, D. C.). Aug. 15, 1960. 15p. (AD-242533)

An analysis was made of the probability distributions of a counting system that requires two particles to be separated by a time, τ, for both to be counted. If a radioactive source emits particles that satisfy a Poisson distribution and an average of ν particles per unit time arrive at the counter, then counting for a period, T, results in a non-Poisson distribution of counts as a result of the dead time, τ. The distribution of counts is slightly skewed to the right, but for sufficiently large T the skewness diminishes and the distribution approaches a normal one. Exact computations with the IBM 704 digital computer are in good agreement with the results given. The mean count, $\overline{K}_\gamma$, is found to approach $\overline{K}_\gamma = (\nu T)/(1 + \nu\tau)$, and, for large T, the standard deviation σ_τ approaches $\sigma_\tau = (\sqrt{\nu T})/(1 + \nu\tau)^{3/2}$. (auth)

11430 (GAMD-1270) METHODS USED IN MGCR NUCLEAR SURVEY. J. M. Stein and H. A. Vieweg (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 1, 1960. 15p. Contract AT(04-3)-187. (MGCR-RP-108; MA-S89-1)

Calculation methods used for the MGCR nuclear survey are outlined. They were reviewed from the standpoint of ease in programing for the IBM-704 using FORTRAN. (T.R.H.)

11431 (IDO-16621) IBM-650 PROGRAM TO CALCULATE NEUTRON-INDUCED RADIOACTIVITIES AND TABLES OF VALUES FOR MTR FACILITIES. M. K. Brice and R. L. Heath (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 30, 1960. 121p. Contract AT(10-1)-205.

An IBM-650 program was prepared to facilitate the calculation of activities induced in materials under neutron bombardment. The quantities computed include the total activity of an element and the partial activities of each of its radioactive species in arbitrary neutron fluxes and for arbitrary irradiation times and the corresponding residual activities after an arbitrary decay period; the saturation activity of each species and the time to attain it; and the time for each species to attain a disintegration rate of 10^9 per second per milligram of the element, together with the total activity of the element when the first of its isotopes capable of doing so reaches this disintegration rate. Tables are given of the above values for all elements in which single neutron capture produces radioisotopes, for five irradiation facilities in the MTR (T2-H2, VG-23, VG-33, VG-7, and VH-2), with an explanation of the table format and a brief discussion of applications of the tables to problems of hazard evaluation and experimental design. The appendixes describe the mathematical methods used, physical assumptions made, and the computer program and its use, and include a listing of the data used to prepare the present tables. (auth)

11432 (JINR-P-235) ANALIZ EKSPERIMENTAL'NYKH DANNYKH METODOM MAKSIMYMA PRAVDOPODOBIYA. (Analysis of Experimental Data by the Maximum Likelihood Method). N. P. Klepikov and S. N. Sokolov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1958. 198p.

The principle of maximum likelihood is defined as the condition at which the probability of the magnitude to be determined is at maximum while the same physical parameters are measured by physical methods. In view of the fact that errors always creep into measurements, the method of maximum likelihood is very useful in establishing whether values obtained by means of known distribution functions, which, however, include undefined parameters, are indeed at the point of maximum probability. The least-square method, regression analysis, graphic interpretations, distribution of estimated values, calculation of systematic errors, confluent analysis, and programing are discussed. The statistical analysis includes the estimation of the regression and dispersion coefficients, refining of the precision of data by successive approximations, and verification of the correlation between hypothesis and experimental data. In the case of scouting experiments, which are not aimed at correct determinations of values, such a detailed statistical analysis is superfluous. (TTT)

11433 (KAPL-M-GES-4) GAM I. A GAMMA CROSS SECTION CODE FOR THE PHILCO TRANSAC S-2000. G. E. Sabian (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 9, 1960. 19p. Contract W-31-109-Eng-52.

Gamma heating, through its effects on flow requirements and thermal stresses, strongly influences the design of many reactors. The magnitude of γ heating in and near reactor cores is often calculated by the use of few-group diffusion theory. GAM I, an Altac Language code for the TRANSAC S-2000 was written to calculate the cross sections required for such diffusion-theory calculations. This report presents the equations used by the GAM I Program, indicates the accuracy of these equations, and describes the input for a GAM I problem. The input for a sample problem is given in the appendix. GAM I gives γ cross sections averaged over an $e^{-\alpha E}$ spectrum and is accurate in the range 0.2 Mev $\leq E \leq$ 6 Mev and $1 \leq Z \leq 40$. (auth)

11434 (NP-9828) COUPLED INTEGRAL EQUATIONS OF THE OMNÈS-MUSKHELISHVILI TYPE. S. W. MacDowell (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). 1960. 7p. (Notas de Física Vol. VI, No. 13, p.287-92.)

A method used in the solution of single integral equations is extended to the case of coupled equations which arise in connection with many-channel γ reactions. The proposed extension is the analog of Bjorken's generalization of the N/D method (Phys. Rev. Letters 4: 473(1960)). (J.R.D.)

11435 (SCTM-334-60(24)) SAMPLED DATA SYSTEMS—A TUTORIAL. R. E. Stephenson (Sandia Corp., Albuquerque, N. Mex.) Nov. 1960. 24p.

A rigorous study of sampled data control systems is very mathematical, so much so that the basic concepts are obscured and difficult to isolate. Basic concepts without mathematical derivation or justification and the impulse method of analysis are presented. The well-known continuous-system techniques of frequency analysis and transient analysis, as obtained from Nyquist's criterion and the root-locus diagram, are adaptable to sampled data systems. These techniques are described, and examples of each method are given. A short bibliography is included. A much more extensive bibliography is included in each of the listed references. (auth)

11436 (TID-11144) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. SWITCHING CIRCUIT THEORY. PART IV. ILLIAC USE AND OPERATION. PART V. IBM 650 USE AND OPERATION. PART VI. GENERAL LABORATORY INFORMATION. (Illinois Univ., Urbana. Digital Computer Lab.). May 1960. 32p. Contract AT(11-1)-415.

High-speed Computer. Work continued on logical design,

circuits, Test Unit No. 2, core storage unit and input-output auxiliary storage. Circuit Research. Brief progress reports are given on high-power drivers, tunnel diode circuitry, flow-gating, and low-impedance two-wire system. Switching Circuit Theory. Work continued on error-correcting codes that correct adjacent bits in a message. Illiac and IBM 650 use and operation are summarized. (T.R.H.)

11437 (WAPD-TM-188) SLOP-1, A THERMAL MULTI-GROUP PROGRAM FOR THE IBM-704. H. Bohl, E. Gelbard, P. Buerger, and G. Culpepper (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1960. 152p. Contract AT(11-1)-GEN-14.

SLOP-1, a thermal multi-group program written for the IBM-704, is discussed. It was used extensively to test the utility of various H_2O scattering kernels, and to assess the accuracy of other computing methods. The problems solved by the code, the physical approximations in the program and library, the method of solution, and suggested modes of operation are described. Derivations of all basic equations and complete input and running instructions are included. (M.C.G.)

11438 ON THE LEAST-SQUARES PLANE THROUGH A SET OF POINTS. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.). Acta Cryst., 14: 185-9(Feb. 10, 1961). (BNL-4555)

A recent discussion by Schomaker et al., of the eigenvalue equation determining the best least squares plane through a set of points is extended. A nondiagonal weight matrix is introduced, the errors associated with the coefficients of the plane are discussed, a criterion for the rejection of a given set as coplanar is given, and a more general form of the equations, valid for the case where certain restrictions are placed on the plane, is presented. (auth)

11439 ON THE GLOBAL ASYMPTOTIC BEHAVIOR OF NONLINEAR SYSTEMS OF DIFFERENTIAL EQUATIONS. J. J. Levin (Massachusetts Inst. of Tech., Cambridge). Arch. Rational Mech. and Anal., 6: 65-74(1960).

An attempt was made to find conditions under which all solutions of $\dot{x} = p(t,n,y)$, $\dot{y} = q(t,x,y)$, and $(\cdot = d/dt)$, where $x = (x_1, \ldots, xn)$ and $y = (y_1, \ldots, yn)$ tend to zero as $t \to \infty$. When these conditions are met, the equations are considered globally asymptotically stable. The existence of an energy function which is positive definite on the entire phase space and whose total derivative is negative definite only on a subspace was assumed. Two theorems and corollaries are discussed and proved in this analysis of the stability properties of differential equations. (M.C.G.)

11440 GREEN FUNCTIONS OF THE MIXED CAUCHY PROBLEM OF THE GORDON-KLEIN EQUATION AND THEIR CONNECTION WITH ADVANCED AND RETARDED GREEN FUNCTIONS. R. Zelazny (Inst. of Theoretical Physics, Univ., Warsaw and Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Bull. acad. polon. sci., Ser. sci., math., astron. et phys., 8: 709-12(1960). (In English)

The Green functions of the mixed Cauchy problem of the Gordon-Klein equation are shown to be intimately related to the advanced and retarded Green functions. (D.L.C.)

11441 USE OF MAGNETIC TAPE FOR DATA STORAGE IN THE ORACLE-ALGOL TRANSLATOR. H. Bottenbruch (Oak Ridge National Lab., Tenn.). Communs. Assoc. Computing Machinery, 4: 15-19(Jan. 1961).

A method for using magnetic tape for data storage in the Oracle-Algol Translator is described. The tapes were used only for storage of arrays, not for simple variables. Four tapes, each having a capacity of approximately 250,000 words, were used. Information was stored in blocks of 128 words. A new declaration was added to the language which declares that one or more arrays are to be stored on one of the four tapes during execution of the program. The declaration began with the new delimeter "tape," was followed first by a number i ($0 \leq i \leq 3$), and then a normal Algol array declaration. A numerical address was given to each location on each of the tapes. An example for using tape arrays and extensions of the techniques to storage of programs on tapes are discussed. (M.C.G.)

11442 HIGH-SPEED TRANSISTORIZED ADDER FOR A DIGITAL COMPUTER. Forrest Salter (Argonne National Lab., Ill.). IRE Trans. on Electronic Computers, EC-9: 461-4(Dec. 1960).

An adder is described that has been developed for the Floating Indexed Point Arithmetic Unit, FLIP, to be used in conjunction with GEORGE, the existing computer built at Argonne National Laboratory. The logic of the high-speed adder and the special circuits required are presented. The adder is parallel, and its high speed is made possible by reducing the carry propagation time. Each bit of the adder contributes one transistor to make up a tall AND gate which reduces the carry propagation time to 0.2 μsec. With this high-speed carry propagation and rather common RCTL transistor circuitry, it is possible to complete an addition in less than 0.25 μsec. (auth)

11443 GENERALIZATION FOR REVERSE PROBLEM OF BOGOLYUBOV ASYMPTOTIC METHOD. P. M. Senik (L'vov Polytechnical Inst.). Izvest. Vysshikh Ucheb. Zavedenii, Mat., No. 6 (19), 226-32(1960). (In Russian)

A method is offered for determining analytical expressions of oscillation factors for the case in which the expression is weakly linear and does not depend on the type of oscillation (damped or forced). The asymptotic method of small parameters and experimental data are utilized in solving the problem. (R.V.J.)

11444 RECURSIVE COMPUTATION OF CERTAIN INTEGRALS. Walter Gautschi (Oak Ridge National Lab., Tenn.). J. Assoc. for Computing Machinery, 8: 21-40(Jan. 1961).

A computing method which consists of evaluating a finite sequence of real numbers by means of a linear first-order recurrence relation and modifications of this method are described. Criteria for determining when forward or backward recurrence is more adequate are given. The invariance of these criteria with respect to linear substitutions on fn and the compution, or choice, of the initial value in the case of backward recursion are discussed. The results were applied to the recursive computation of the integrals

$\beta_n(x) = \int_1^1 t^n e^{-xt}\,dt$ and $E_n(x) = \int_1^\infty t^{-n} e^{-xt}\,dt$. (M.C.G.)

11445 ON A MANY-DIMENSIONAL BWK APPROXIMATION. Don H. Secrest and Joseph O. Hirschfelder (Univ. of Wisconsin, Madison). Proc. Natl. Acad. Sci. U. S., 47: 227-40(Feb. 1961).

The possibility of generalizing the BWK approximation to nonseparable many-dimensional problems is discussed. There are two types of difficulty encountered. First, the solution of the nonseparable many-dimensional classical Hamilton-Jacobi equation may be even more difficult than the solution of the original Schrödinger equation. Second, a procedure must be developed for making the necessary connections between the BWK solutions in the classical and nonclassical regions. The usual BWK connection formula would be very difficult to generalize or to use in a many-dimensional problem. Three somewhat simpler types of connection formulas are examined which might be more

suited for this purpose. The energy calculated by these alternative procedures differs from the standard BWK value only in having a slightly different zero-point energy. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

11446 (AD-242211) ANNOTATED BIBLIOGRAPHY ON PLATING WITH CHROMIUM AND NICKEL. B. H. Nagel (Autonetics Div., North American Aviation, Inc., Downey, Calif.). Feb. 10, 1960. 168p. (EM-5989).

A bibliography is given of literature published between 1955 and 1959 concerning processes and problems of plating with chromium and nickel. The 461 references are arranged chronologically and followed by author and subject indexes. (auth)

11447 (AFOSR-116) SOME COMMENTS ON THE AUSTENITE-MARTENSITE INTERFACE. C. M. Wayman (Illinois. Univ., Urbana). Jan. 1961. Contract AF49(638)-420. 14p.

Observations related to the dilation in austenite-martensite interface and a review of information on austenite-martensite crystallography are presented. It is concluded that an interface dilation parameter is probably anisotropic and that it may be necessary to rewrite the presently accepted one-parameter uniform dilation theory. More complete reconciliation between theory and experiment may be made, and clues concerning transformation dislocation may be obtained by recognizing this non-uniformity. (auth)

11448 (BMI-1469) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING SEPTEMBER, 1960. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1960. 77p.

The study of possible reactions induced by the application of high pressures at high temperatures was concentrated on $U_3O_8-Al_2O_3$. Data are reported on the effects of temperature on the tensile properties of fully recrystallized Cr-Nb, Nb-V, Nb-Zr, and Cr-Nb-Zr alloys. The effect of radiation on the creep properties of Zircaloy-2 at elevated temperatures is being studied. Magnesium oxides are being evaluated as a fuel matrix material for uranium dioxide. Specimens of niobium-base binary alloys containing 10, 20, and 30 wt.% uranium and ternary alloys containing 20 wt.% uranium with 10 or 20 wt.% Zr were prepared with enriched uranium for irradiation tests. Pu-Nb, Pu-Th, Mo-Pu-U, and Nb-Pu-U alloys were selected as candidates in the search for improved irradiation resistance. Specimens consisting of uranium nitride dispersed in C, Cr, Fe, Mo, Nb, Ta, Ti, W, and Zr were fabricated and heat-treated to evaluate compatibility. A summary of results is presented from 3 hr, 1430°C, 5 tsi hydrostatic pressings of various types of uranium carbide and U-C-Nb systems. The effects of heat-treatment on some properties of U-C systems are presented. Data are presented on the corrosion resistance of UC-Mo_2C, UC-NbC, UC-TiC, UC-VC, UC-ZrC-Mo_2C, and UC-ZrC-VC to Santowax R at 350°C for 7 days. The development of powder metallurgy and melting and casting techniques for uranium nitrides is reported. Creep and stress-rupture tests are reported on Zircaloy-2 sheet specimens. Fission gas release experiments are reported on fueled-graphite spheres in support of the Pebble-bed Reactor. In the development of container materials for LAMPRE applications, the fabrication behavior of 13 binary tantalum-base alloys was investigated. Radiation-effects studies of fuel specimens of UO_2 dispersed in BeO and Al_2O_3 and UC and UC_2 dispersed in graphite are reported. Studies are being conducted to develop an instrumented fuel plate for irradiation in the SM-1 and to develop fuel, absorber, and suppressor materials for the SM-2. A process is being investigated for the fabrication of dense BeO-UO_2 fuel pellets by cold pressing and sintering. A program to study the effects of irradiation on Hastelloy-X-clad compacts of highly enriched UO_2 is in progress. Thorium samples were nickel plated for corrosion testing under atmospheric conditions and in water-saturated air at 120 and 200°F. Data are reported on the corrosion of thorium, uranium, and U-10 wt.% Mo alloy under three types of conditions. (For preceding period see BMI-1464.) (W.L.H.)

11449 (DMIC-Memo-82) REVIEW OF DEVELOPMENTS IN IRON-ALUMINUM-BASE ALLOYS. J. W. Holladay (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 30, 1961. 63p. (PB-161232)

Information is presented on current developments in aluminum-iron-base alloys. Phase diagrams, fabrication methods, and corrosion properties of austenitic and ferritic alloys are discussed. 99 references. (OTS)

11450 (DMIC-Memo-85) PICKLING AND DESCALING OF HIGH-STRENGTH, HIGH-TEMPERATURE METALS AND ALLOYS. J. A. Gurklis and L. D. McGraw (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 8, 1961. 19p. (PB-161235)

Chemical and electrochemical descaling and pickling procedures are described which have been employed on high-strength high-temperature metals and alloys. The oxides and scales on refractory metals and high-strength high-temperature alloys have high resistance to chemical attack, and very reactive chemical solutions are required for descaling and pickling. Procedures are given for the treatment of beryllium, titanium, molybdenum, niobium, tantalum, vanadium, tungsten, stainless steels, and various alloys, including chromium-iron-nickel, iron-molybdenum-nickel, and chromium-iron-molybdenum-nickel. (C.H.)

11451 (ERD-TN-60-768) A SURVEY OF THE LITERATURE ON THE USE OF ORGANOMETALLIC COMPOUNDS IN THE PREPARATION OF ULTRA-PURE METALS. Scientific Report No. 1. W. A. G. Graham (Little (Arthur D.) Inc., Cambridge, Mass.). July 15, 1960. Contract AF19(604)-4975. (AD-242291). 43p.

A survey was made of the literature on methods for recovering metals from organometallic compounds. Possible recovery methods are thermal decomposition, photolysis, electrolysis, and hydrogenolysis. These were appraised from the contamination of the product by organic residues. Reactions of metals with gaseous organic-free radicals were reviewed, but do not appear attractive as a means of purification. Reactions of organic-free radicals in solution with metals are discussed. 127 references. (auth)

11452 (HW-66910) OUT-OF-REACTOR EVALUATION OF COMPONENTS AND ASSEMBLIES-MARK I SWAGED UO_2 PRTR FUEL ELEMENT. M. K. Millhollen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1, 1960. Contract AT(45-1)-1350. 23p.

Quality of the Zircaloy-clad, swaged UO_2 19-rod cluster fuel elements fabricated for the Plutonium Recycle Test

Reactor was controlled by a series of out-of-reactor proof and acceptance tests. Many of these tests were developed during fabrication of the loading. Cladding and UO_2 acceptance tests were especially important because these original constituents determined the final quality of the finished fuel element. Additional proof tests were applied to completed fuel rods before final assembly into fuel-element clusters, as well as to completed fuel elements. (auth)

11453 (NMI-2090) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for October 1960. (Nuclear Metals, Inc., Concord, Mass.). Nov. 21, 1960. 32p. Contract AT(30-1)-1565.

In the hot extrusion program only fabrication of the enriched irradiation samples and selection of the irradiation facility remained as objectives. Bend tests are reported on Zircaloy-2-clad U–2 wt.% Zr alloy, aluminum-clad Al–26 wt.% U alloys, and Zircaloy-4-clad uranium honeycomb type fuel elements. Yttrium metal was fabricated with a protective copper cladding at elevated temperatures, without a protective cladding, and at ambient temperatures. All material was taken from the 2-in.-diameter bar produced by primary extrusion of the cast ingot. The design of a fuel fabrication plant capable of handling U^{233} is in progress. The program to determine whether the retained β phase in uranium-base alloys is stabilized by neutron bombardment and whether the swelling rate of β-phase uranium is less than that of α uranium was continued. Research into the mechanism of the corrosion of zirconium alloys in high-temperature steam, with emphasis on the role of intermetallic precipitates, was continued. The preparation and thermal analysis of Be–Ce, Be–Cu, Be–La, Be–Mn, Be–Ni–Co, and Be–Fe–N; alloys are reported. Elevated temperature tensile tests on pure beryllium and a Be–8 at.% Ni alloy are in process. (For preceding period see NMI-2088.) (W.L.H.)

11454 (NMI-2092) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for December 1960. (Nuclear Metals, Inc., Concord, Mass.). Feb. 7, 1961. 34p. Contract AF(30-1)-1565.

Hot extrusion of stainless-steel-clad UO_2 rods 40 to 44 in. long is reported. Attempts at forming spiral and ribbon candy fuel elements from plates of clad fuel material are described. A flat sheet, with dimples for spacing between spirals, was wrapped around a mandrel with moderate success. Ribbon candy configurations were forged of dimpled plate into a zig-zag shape, then the bends were continued until the sides of the vees became parallel. The technique was satisfactory. Extrusion of unclad cast yttrium from a 6.05-in. liner through a 2.015-in. die was performed, then 1.995-in. billets were reduced to 0.400 in. Studies were also made of the swaging behavior of extruded yttrium. The microstructure of the extruded material is described. Progress in U^{233} recycle processing is described. Results of metallographic examinations of metastable β-phase uranium-base alloys in various conditions prior to irradiation tests are given. Hydrostatic fabrication studies continued with attempts to extrude a copper billet in molten lead at 900°F. Data from the study of zirconium alloy corrosion include pressure-composition isotherms at 680°C for H_2 and Zr, $ZrMo_2$, Zr_2Cu, $ZrFe_2$, Zr_2Ni, $ZrCr_2$, $ZrSn_2$, ZrW_2, $ZrAl_2$, and Zr_2Fe. Beryllium research produced thermal effects data from the second cycle through the phase transformations for Be–Co–Fe–Ni, Be–Co–Ni with Mn, and Be–Ni with Cu. (For preceding period see NMI-2091.) (T.R.H.)

11455 (NMI-9505) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period July 1, 1960 to September 30, 1960. S. H. Gelles (Nuclear Metals, Inc., Concord, Mass.). Nov. 10, 1960. 94p. Contract AF33(616)-7065.

Work is reported on the preparation of pure beryllium metal by the iodide decomposition method. The ultrasonic welding of beryllium to beryllium, aluminum, copper, iron, and titanium is being investigated. An investigation is reported on the role of oxide and voids in beryllium. Work is reported on the factors that contribute to the brittle behavior of beryllium. Work was completed on the effects of surface damage in beryllium. Results showed that surface damage introduced by machining resulted in lower mechanical properties. Removal of the surface damage by chemical etching restored the properties. Work is being conducted to evaluate the room-temperature and elevated-temperature mechanical properties of silver-brazed beryllium lap joints as a function of brazing variables and post-braze treatment. The purification of beryllium by distillation from both liquid and solid phases is reported. A study is reported on aging and strain aging in extruded polycrystalline beryllium rod in terms of mechanical and microstructural parameters. A study is being made of the effect of cold work, alloying, and heat-treatment on the yield strength of beryllium sheet. (W.L.H.)

11456 (NP-9819) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Bi-monthly Progress Report, November 2, 1960 to January 1, 1961. G. E. Spangler and M. Herman (Franklin Inst. Labs. for Research and Development, Philadelphia). 5p. Contract NOw 61-0221-d. (P-A2476-1)

Zone refining operations were started for Pechiney beryllium rods. A spark-discharge device was designed for machining tensile specimens from material being zone melted. A discussion is given of the potential for calcium as a deoxidizing agent for reducing BeO on the rod surface. (B.O.G.)

11457 (NP-9833) DEVELOPMENT OF ULTRA REFRACTORY MATERIALS. Progress Report No. 23, November 1, 1960 through January 31, 1961. Peter T. B. Shaffer (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). Feb. 3, 1961. 12p. Contract NOrd-17175.

Results of a fundamental study of zirconium carbide–tantalum carbide systems are reported. Data on microhardness, lattice parameters, electrical resistivity, and Young's modulus were obtained over a range of compositions. The investigation was conducted primarily to find an explanation for anomalies such as the increased melting temperature, strength, and creep resistance observed in these solid solutions. Results indicate the existence of a complete, stable solid solution series between these carbides. (J.R.D.)

11458 (NP-9841) DEVELOP PROCESS FOR AND ARC CAST 25 TO 50 POUND INGOTS OF TIN REDUCED MOLYBDENUM. Progress Report for the Period December 31, 1960–January 31, 1961. Allen D. Abraham (Oregon Metallurgical Corp., Albany). Contract NOrd-18124. 5p.

Several runs of molybdenum fabrication by tin reduction were made using an argon atmosphere in place of hydrogen. The system works extremely well in argon. Briquettes similar to those made previously appeared to separate, leaving high tin and high sulfur areas. This made reduction time longer. Tablet-size charges were made which appeared to be superior to briquettes on initial evaluations. Reduction times using tablets appeared to be comparable to those using briquettes in hydrogen. No sulfur attack on molybdenum boats was noted in argon. The charge and boat were extremely shiny after reduction runs. In hydrogen the charge appeared to be coated with tin; whereas the boats

appeared to be attacked by sulfur or H_2S. Boats would scale and become thinner with use. (auth)

11459 (ORO-365) COLUMBIUM ALLOY CLAD URANIUM CARBIDE FUEL ELEMENT. Monthly Letter Report for the Period Ending December 31, 1960. J. J. Finley, M. Korchynsky, and G. Reinhardt (Union Carbide Metals Co., Niagara Falls, N. Y.). 6p. Contract AT-(40-1)-2559.

A process is presented for the preparation of uranium carbide by reacting uranium powder with a stoichiometric amount of methane gas. An investigation of the slip casting of uranium carbide was initiated. Microhardness measurements on the uranium dicarbide phase were continued. (W.L.H.)

11460 (PRL-5.29) FLUIDS, LUBRICANTS, FUELS AND RELATED MATERIALS. Quarterly Report, January, February, and March 1960. (Pennsylvania State Univ., University Park. Petroleum Refining Lab.). Mar. 31, 1960. Contract AF33(616)-5460. 74p.

A study of the evaporation test and the significant variables influencing the test results is presented. The evaporation properties of formulated fluids and base stocks are discussed as a function of viscosity level. Evaporation rate is also treated as a function of boiling range of the test fluid for wide boiling-range materials, pure compounds with a specific boiling point, and blends of narrow boiling-range materials. The importance of vapor pressure in the determination of evaporation is discussed. The relationship of this evaporation phenomena to equilibrium distillation is treated mathematically. The significance of gas density on evaporation rate is shown. The importance of oxidation mechanism on evaporation is demonstrated by comparing values for fluids with and without oxidation inhibitors in air with nitrogen tests. Differences in oxidation mechanisms are shown for mineral oils, esters, and polyolefins by these studies. A fundamental study of the variables in the evaporation test is presented. The effects of test time, temperature, atmosphere, quantity of fluid charged, and additives present in the fluid are discussed separately. A series of tests in the Shell four-ball wear and extreme pressure testers was conducted at 167 to 700°F. The effect of increasing temperature on lubrication is illustrated as a function of test variables such as: lubricant base stock type (mineral oils, dibasic acid esters, neopentyl esters of monobasic acids, silicones, silicates, polyphenyl ethers, and a chlorinated aromatic), lubricity additives (tricresyl phosphate and diisopropyl acid phosphite), and metal-bearing system (52-100 bearing steel, MHT steel, vacuum-melted 52-100 steel, SAE 51-100 steel, M-10 tool steel, M-50 tool steel, M-50 consutrude steel, and stainless steel). These tests are designed to show the combined effects of the physical changes in the bearing material with temperature, the chemical reactivity of the lubricant at high bulk oil temperatures, and the effect of temperature on fluid volatility. The effect of super-refining on the wear properties of mineral oils and hydrocarbons is demonstrated. (auth)

11461 (SCNC-301) QUARTERLY TECHNICAL PROGRESS REPORT FOR PERIOD ENDING JUNE 31, 1959. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). Aug. 1959. Decl. Dec. 29, 1959. 30p. Contract AT-30-[1]-GEN-366.

The results of work indicate that fused UO_2 powder has the best properties for obtaining densities above 92% of the theoretical value by hot isostatic pressing techniques without pleating of the cladding. A sample with the highest compacted density obtained was made by using a blend of 75% coarse fused UO_2 and 25% fine ceramic UO_2 powders. Thermal cycling data are presented for several U–Y alloys that were cycled 500 times between 725 and 225°C. The effect of compacting pressure on green strength density of 65U–35Y alloys is reported. Data are reported on the thermal conductivities of U–Y alloys. Attempts to prepare UO_2–Y_2O_3 to above 90% of theoretical density were continued. A sample of UO_2–Nb_2O_5 was prepared to 92% of theoretical density. Data are presented on the thermal expansion, steam corrosion, and elastic modulus and compressive strength of UO_2, UO_2–CeO_2, UO_2–U_2O_3, and UO_2–Nb_2O_5. Thermal expansion, steam corrosion, and elastic modulus data are reported for ThO_2–UO_2 systems. (W.L.H.)

11462 (TID-11294) THE DEVELOPMENT AND TESTING OF HOMOGENEOUS CERAMIC FUELS. Progress Report for Period, May 15–August 31, 1959. G. Zuromsky (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). 18p. Contract AT(30-1)-2379. (NYO-2740)

Activities in a program concerned with the development and testing of dilute UO_2 ceramic fuels, consisting of homogeneous solid solutions of UO_2 in ZrO_2 or CeO_2, are summarized. A survey of the literature was conducted which indicates that cubic solid solutions may form in the ZrO_2-rich region of the UO_2-ZrO_2-CaO system. The UO_2-CeO_2 system forms solid solutions over a wide range. Analyses indicate that monoclinic and cubic ZrO_2, as well as $CaZrO_2$ phases, were formed with increasing additions of CaO. (J.R.D.)

11463 (USBM-U-783) QUARTERLY METALLURGICAL PROGRESS REPORT NUMBER 9 FOR THE PERIOD OF OCTOBER 1, 1960 TO DECEMBER 31, 1960. (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599.

Sodium Reduction of Thorium Tetrachloride. Filtering molten thorium tetrachloride through molybdenum wool and porous Inconel effectively removes any carbon present. Thorium metal was prepared containing 500 to 1350 ppm oxygen and 20 to 200 ppm carbon. The metal was successfully arc-melted and cold-worked into bar, rod, and sheet. Uranium Reduction Studies. Boron nitride appears to be the only suitable crucible material for the reduction of UF_6 with magnesium. Crucible temperatures approximate 1200°C. Zirconium-Hafnium Separation. Approximately 90 to 95% of complex fluo salts of zirconium and hafnium prepared by fusing zircon and potassium silicofluoride can be leached from the frit with hydrofluoric acid. An enriched fraction containing over 10% hafnium can be produced by the selective reduction of mixed hafnium-zirconium chlorides. Hafnium Alloys. A tentative hafnium–tantalum phase diagram was developed and an investigation of the hafnium–vanadium system was started. Rare Earth Alloys. A gadolinium–iron diagram was completed, and gadolinium–nickel and iridium–titanium diagrams are nearing completion. Ternary alloys of chromium–gadolinium–iron were studied. Niobium-Tantalum Welding. An inert atomsphere welding chamber was completed, and preliminary welding tests on zirconium sheets were started. Difficulty in obtaining suitable tantalum sheet delayed the welding studies. Melting Research. Evaluation of models of finned, air-cooled crucibles indicated that spacing of fins may be critical. Film coefficients were developed for cooling in an air-water-cooled crucible. Electron-beam melting of reactor materials was beset with difficulties; it appears that most of them were overcome. Several attempts to cast hafnium carbide were made. Most of the castings show considerable porosity. (For preceding period see USBM-U-761.) (auth)

11464 (WAPD-ZH-26) ZIRCONIUM HIGHLIGHTS. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1960. 31p. Contract AT-11-1-GEN-14.

Information on the technology of zirconium is presented. Separate abstracts have been prepared for the four papers included in the report. (J.R.D.)

11465 (WAPD-ZH-26(p.1-7)) OBSERVATIONS OF THE SHORT-TIME ELEVATED TEMPERATURE TENSILE TESTING OF ZIRCALOY-2. J. H. Schemel and H. L. Kall (Carborundum Metals Co., Inc., Akron, N. Y.).

A study was conducted of factors which affect the short-time tensile test of Zircaloy-2 at 600°F. Results indicate that this test may be improved and broadened by use of different specimens. If the change to these specimens is adopted, the specifications should be adjusted to reflect the true elongation values, and some adjustment should be made to compensate for the lower ductility normally found in heavy forged sections. (J.R.D.)

11466 (WAPD-ZH-26(p.8-16)) THE BENDING FATIGUE PROPERTIES OF ZIRCALOY-2. J. G. Weinberg (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Information obtained in a program to test the bending notch fatigue properties of Zircaloy-2 is presented. The data are summarized tabularly and presented in graphs of stress vs. log of number of cycles to failure. It is concluded that under completely reversed loading, there appears to be no significant difference in the notched fatigue properties of Zircaloy-2 with K_T (theoretical stress concentrations) values of 3 and 9 up to 10^6 cycles at 600°F. However, for longer lifetimes the $K_T = 9$ specimens show a further reduction in fatigue strength. The influence of a superimposed static stress on an alternating stress for notched Zircaloy-2 causes a reduction in the fatigue strength. (J.R.D.)

11467 (WAPD-ZH-26(p.17-19)) THE EFFECT OF NITROGEN ON THE LATTICE CONSTANTS AND HARDNESS OF ZIRCONIUM. J. D. Grozier (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Results of a study are presented to determine the effects of nitrogen in concentrations up to 5 wt.% on the hardness and lattice constants of zirconium. Results show that nitrogen hardens and expands the α zirconium lattice up to approximately 3.5% nitrogen. Above this concentration, increasing amounts of nitrogen do not affect the α phase hardness but only increase the amount of ZrN phase present. (J.R.D.)

11468 (WAPD-ZH-26(p.20-8)) EFFECT OF COOLING RATE ON THE CORROSION RESISTANCE OF ZIRCALOY-4. J. G. Goodwin (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Results of lifetime corrosion testing of Zircaloy-2 and -4 are presented for samples which were cooled from the β to the α phase at various rates. Duplicate corrosion tests in 680°F water for these two alloys show no significant difference in weight gain caused by cooling rate. Similar tests in 750°F steam show that slower cooling rates resulted in increased weight gain for both alloys. (J.R.D.)

11469 (WCAP-1647) THERMOELECTRIC NUCLEAR FUEL ELEMENT QUARTERLY PROGRESS REPORT – JULY–SEPTEMBER, 1960. G. R. Kilp, W. P. Blankenship, R. C. Goodspeed, R. A. Markley, and P. V. Mitchell (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Oct. 10, 1960. Contract AT-(30-3)-500. 55p.

Seven binary and ternary uranium chalcogenides were prepared for melting in helium-filled tantalum bombs. The USTe material is to be swaged into a test device for thermoelectric measurements. Commercial purity PbTe is being processed in a graphite-steel bomb to learn if it can be used to realize substantial cost savings. Property measurement results are listed for various telluride thermoelectric materials and elements, and for various devices for irradiation evaluations. Life tests of PbTe elements have been running for 1700+ hr. Results are analyzed for a Westinghouse Testing Reactor (WTR) irradiation test sample. Preinstrumentation techniques were developed to improve the amount and quality of information being secured from swaged elements under test. Calculations were made on thermal cascaded thermoelectric elements, and powder metallurgy dies for producing such elements were procured. Results of compatibility studies of PbTe and GeTe with various structural materials were reported. Data were obtained for the Case II thermoelectric reactor core designs. The design features high-enrichment fuel, a Be-UO_2 fuel matrix with a Cu-Fe inner electrical conductor and an aluminum outer conductor. Work began on the evaluation of a low-enrichment (Case III) design. (auth)

11470 (AEC-tr-4430) EFFECT OF NONMAGNETIC SUBSTITUTION IMPURITIES ON MAGNETIC METAL COUPLES. APPLICATION TO ELECTRICAL RESISTIVITY. Y. A. Rocher (Paris. Université, Orsay. Ecole Normale Superieure. Faculté des Sciences). 22p.

A model is used to aid in explaining the effects of nonmagnetic impurities on the electric and magnetic properties of magnetic metals. Low-temperature changes in magnetic structure around impurities are studied and related to the sign and strength of the indirect interaction. Results are used to calculate the electric resistivity. The model seems appropriate to explain the properties of manganese–copper and plutonium–aluminum alloys. (J.R.D.)

11471 (AWRE/Trans/14) THE ROSIN-RAMMLER DISTRIBUTION OF PARTICLE SIZE IN POWDERS. R. Brenner and A. Vidmajer. Translated by J. R. T. Lloyd (Atomic Weapons Research Establishment) from Metall, 9: 305-403(1955). 27p.

Empirical formulas are derived for particle distribution in ground powders and for the properties of powders produced by grinding. The distribution functions of a series of particle characteristics are deduced, and it is shown that distribution maxima can be determined if certain distribution parameters are known. Deductions of special characteristics of a particular fraction or determination of a fraction with certain particle characteristics are given along with those for use in summation values and the mean particle characteristics value. The significance of the distribution parameter is briefly described, and the dependence of the position and value of the distribution maxima of these parameters is examined. (J.R.D.)

11472 (CEA-tr-A-631) DECARBURATION PAR L'HYDROGENE D'ALLIAGES FER-CARBONE PURS ET D'ACIERS ALLIES. (Hydrogen Decarbidation of Pure Iron-Carbon Alloys and Alloy Steels.) W. Baukloh and W. von Kronenfels. Translated into French by R. Carbonnier from Arch. Eisenhüttenw., 11: 145-56(1937). 49p.

A study was made of decarbidation of carbon–iron systems with up to 1.7% carbon. At temperatures below the PSK line, it is the rate of diffusion of H_2 which determines the course of the decarbidation. Above 700° it obeys another law which results from the combined effect of a series of factors. From the experiments it is shown that the state in which the carbon is formed has a direct effect on the decarbidation by heating in H_2. Even though the cementite or, respectively, the combined carbon is the more unstable form and more easily hydrided, it results in a decrease in decarbidation, favoring a particularly dense

lattice compared to material containing graphite. The effects of different additive on decarbidation at various temperatures and carbon contents elements were studied also, including Si, Mn, Ni, Cr, W, Ti, and Al. Even in small quantities these elements have an important effect. According as they dissolve in iron or retain carbon in solution more strongly by stable carbide formation, they modify the diffusion rate of both H_2 and carbon. It is not possible to classify them by this criterion, however. (tr-auth)

11473 (CEA-tr-R-1079) ETUDE DE LA THERMODYNAMIQUE DE LA RÉACTION DE RÉDUCTION DE L'OXYDE DE BÉRYLLIUM PAR LE CARBONE. (Study of the Thermodynamics of the Reaction of Reduction of Beryllium Oxide by Carbon). M. V. Smirnov and N. Ya. Chukreev. Translated into French by B. Vinogradoff from Zhur. Neorg. Khim., 3: 2445-9(1958). 15p.

The emf of galvanic elements composed of a metallic beryllium electrode and BeO–C electrode placed in a fused equimolecular mixture of NaCl and KCl containing 1 to 3 wt% $BeCl_2$ was measured between 682 and 1040°C. From the experimental data, the variation of the isobar potential of the reaction $Be_{sol} + 0.5CO_2 \rightarrow BeO_{sol} + 0.5C_{graphite}$ was determined. From experimental and published data the standard values for the formation and entropy heats were calculated for BeO. (tr-auth)

11474 ETCH PITS AT DISLOCATIONS IN COPPER. F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 32: 192-201(Feb. 1961).

A possible mechanism for the development of etch pits at dislocations in copper by etching in solution is presented, and experiments are described which may substantiate this mechanism. Etchants that will develop pits at clean dislocations on the (1 1 1), (1 0 0), and (1 1 0) faces of copper are described. These etchants are capable of distinguishing between clean dislocations and dislocations with a "Cottrell atmosphere" in 99.999% copper. Clean edge and screw dislocations can also be differentiated with these etchants. Some observations concerning the relation of facet structure, developed by etching, to the dislocation structure of the crystal are reported. (auth)

11475 SPUTTERING OF VITREOUS SILICA BY 20- TO 60-KEV Xe^+ IONS. R. L. Hines and R. Wallor (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 32: 202-4(Feb. 1961).

Experimental values for the sputtering of quartz by xenon positive ions at flux densities of 2×10^{15} ions/cm^2/sec in a vacuum of 10^{-5} mm Hg are found by measuring the volume of the sputtered cavity by means of interference fringe contours. The sputtering ratios are 0.706 ± 0.061 at 20 kev, 0.85 ± 0.13 at 30 kev, 1.78 ± 0.13 at 40 kev, 1.74 ± 0.12 at 50 kev, and 1.31 ± 0.09 at 60 kev. The technique of volume measurement by interference fringe contours has an accuracy of $\pm 2 \times 10^{-9}$ cm^3 and is estimated to have an ultimate accuracy of $\pm 10^{-10}$ cm^3. (auth)

11476 PROBLEMS OF LUBRICATION IN SPACE. M. M. Freundlich (Airborne Instruments Lab., Deer Park, L. I., N. Y.), and C. H. Hannan. Lubrication Eng., 17: 72-7 (Feb. 1961).

With the aim of being able to eventually operate small motors in space for a period of over a year, a large number of standard or experimental oils and greases was collected and tested in three phases. In the first phase, the lubricants with highest evaporation rates in tests in a vacuum of 10^{-7} mm Hg were eliminated. The fifteen best of those remaining after life-testing were finally tested as lubricants in R-2 size bearings in motors operating at 4000 rpm in a vacuum of 10^{-6} mm Hg. After 1000 hr of operation, an inspection of the disassembled bearings showed that several oils and oil-grease combinations deteriorated during these tests to only such a slight extent that it could be assumed that they would have operated for a considerably longer time. (auth)

11477 METAL COATINGS (1950–1960). OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). 20p. (SB-409)

This bibliography includes about 400 references on metal coatings. The references are arranged in sections for general information, electroplating, vapor deposition, phosphate coatings, and plating. The period covered is 1950 to 1960. (J.R.D.)

11478 MATERIALS FOR NUCLEAR ENGINEERS. A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960. 379p. $11.85.

Nine papers are presented on the subject of reactor materials. They deal with the application and extrapolation of materials information in nuclear engineering and with eight specific materials: uranium, plutonium, thorium, ceramic fuels, graphite, magnesium, beryllium, and zirconium. Their occurrence, extraction, and fabrication are discussed, and data on their physical and mechanical properties and radiation effects are reviewed. Separate abstracts have been prepared for eight of the papers. (D.L.C.)

11479 URANIUM. R. W. Nichols (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). p.8-63 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The occurrence, extraction, and preparation of uranium metal are reviewed, and its physical properties are treated in detail. The effects of various factors, e.g., rolling temperature, fabrication history, and thermal cycling on its mechanical properties are shown. The creep properties are also considered in detail. Compatibility of uranium with other materials is discussed with particular reference to use in reactors; the behavior of uranium in contact with aluminum, iron and nickel alloys, hydrogen, steam, pressurized water, air, etc., is reviewed. The fabrication of uranium for reactor use is reviewed, and the effects of reactor conditions, particularly irradiation, on the properties of uranium are shown. An extensive appendix on the properties of uranium is presented. (D.L.C.)

11480 PLUTONIUM. K. Q. Bagley (Dounreay Works, Caithness, Scotland). p.64-111 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The availability and extraction from irradiated uranium of plutonium is briefly reviewed, and the nuclear properties of the various plutonium isotopes are tabulated. The physical and mechanical properties of plutonium and some of its alloys and intermetallic compounds are treated in detail. Its reactive properties, e.g., oxidation, reduction, and reactions with liquid metals, are reviewed. No liquid metals are likely to be compatible with plutonium because of intermetallic compound formation. The fabrication, handling, and hazards of plutonium are discussed. The possibility of using plutonium as reactor fuel and various ways of doing this are briefly considered. An extensive appendix is included which presents data on the structure of plutonium compounds and phase diagrams for many plutonium systems. (D.L.C.)

11481 THORIUM. I. P. Bell (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). p.112-32 of "Materials for Nuclear Engineers." A. B. McIntosh and

T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

Thorium, a fertile material which produces U^{233}, has superior properties as a reactor fuel to those of uranium. Its occurrence and extraction are reviewed, and its physical and mechanical properties are treated in detail. The compatibility of thorium and thorium alloys with water, gases, liquid metals, and solids is considered. The fabrication of thorium is discussed, particularly melting, casting, powder metallurgy, working, machining, and welding. The limited information on the reactor radiation effects on thorium alloys is reviewed. The radiation stability of thorium as compared with uranium is due to its isotropic form and high creep strength. (D.L.C.)

11482 CERAMIC FUELS. R. W. Nichols (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). p.133-70 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The advantages of ceramic fuels over metallic fuels are greater dimensional stability in reactors, greater resistance to chemical attack, and higher permissible fuel temperatures. A table of possible ceramic materials and their densities and melting points is presented. Five compounds are considered in detail: UO_2, UC, U_3Si, U_3Si_2, and ThO_2. The following items are reviewed for all five compounds: manufacture, fabrication, and physical mechanical, and chemical properties. Radiation effect data are reviewed, mostly for UO_2. Phase diagrams are included for the oxygen–uranium and silicon–uranium systems. (D.L.C.)

11483 GRAPHITE. W. G. O'Driscoll (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.) and J. C. Bell. p.171-218 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The advantages and disadvantages of graphite as a reactor material are given, and its manufacture is briefly reviewed. Its physical properties and their temperature dependence are discussed: density, permeability, vapor pressure, thermal conductivity, thermal expansion, emissivity, and electrical resistivity. Mechanical properties and their temperature dependence are also discussed. A comparison is made between the moderating properties of graphite and other possible moderators. The compatibility of graphite with some gases used as reactor coolants and with liquid metals is treated. The effects of reactor radiation on the properties of graphite are discussed: growth, conductivity, mechanical properties, energy storage, and damage annealing. (D.L.C.)

11484 MAGNESIUM. T. J. Heal. p.219-68 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The reasons for the use of aluminum rather than magnesium as a canning material for the Windscale reactors are given, and the present status of magnesium as a canning material is summarized. The occurrence and extraction of magnesium is briefly considered, and the physical and mechanical properties of magnesium and magnesium alloys are treated in detail, particularly cavitation and creep. Recent developments in canning alloys are discussed, e.g., Magnox A12, ZA, ZW1, etc. A survey of the compatibility of magnesium alloys with other metals, air, O_2, CO_2, hydrogen, and aqueous media is given. The fabrication of canning alloys is discussed. The effects of reactor radiation on the mechanical properties are reviewed. It is concluded that magnesium alloys can be utilized as canning materials for reactors with outlet gas temperatures of more than 400°C. (D.L.C.)

11485 BERYLLIUM. L. R. Williams and P. B. Eyre (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.). p.269-318 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

The applications of beryllium in reactors are briefly described; its advantages for canning are low absorption of thermal neutrons and high strength-to-weight ratio. Its occurrence and extraction are reviewed. The compositions of beryllium produced by electrolytic reduction of the chloride and by magnesium reduction of the fluoride are compared. Preparation of super-pure beryllium is discussed. The physical and nuclear properties of beryllium are briefly described. Fabrication is treated in some detail: casting, melting, powder metallurgy, working, and joining. The mechanical properties of beryllium are then reviewed. The use of beryllium to can uranium metal is discussed. Data on the compatibility of beryllium with air, hydrogen, CO_2, water, liquid metals, and solids are reviewed. The toxic effects of beryllium and prevention of beryllium poisoning are considered. The status of beryllium as a reactor material is summarized. (D.L.C.)

11486 ZIRCONIUM. C. Tyzack (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). p.319-66 of "Materials for Nuclear Engineers." A. B. McIntosh and T. J. Heal, eds. New York, Interscience Publishers, Inc., 1960.

Zirconium is the only metal of low cross section which is corrosion-resistant to pressurized water at ~300°C. Reactor applications of zirconium are summarized, and their occurrence and extraction are briefly reviewed. The physical and mechanical properties, particularly creep, of zirconium and the effects of various impurities thereupon are reviewed. Data are reviewed on the corrosion of zirconium and zirconium alloys in gases and aqueous media. Fabrication and joining are discussed. Radiation effects on the mechanical properties are reviewed. (D.L.C.)

11487 PROCEEDINGS OF THE FOURTH CONFERENCE ON CARBON HELD AT THE UNIVERSITY OF BUFFALO, BUFFALO, NEW YORK. New York, Pergamon Press, 1960. 790p. $22.50.

Eighty papers are included from the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York, June 15-19, 1959. The physical and chemical properties, methods of fabrication, irradiation behavior, and uses of carbon are discussed. Separate abstracts have been prepared for 30 of the 80 papers. (T.F.H.)

11488 PHYSICAL ADSORPTION AND THE SURFACE AREAS OF CARBON BLACKS. L. L. Lyon, G. R. Crocker, and J. S. Dahler (Univ. of Wichita, Kan.). p.71-7 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Nitrogen adsorption-desorption investigations at liquid nitrogen temperature of porous systems find hysteresis in the relative pressure (p/p_s) region of 0.5 to 1.0. This hysteresis is attributed to the action of surface tension at a curved meniscus formed by capillary condensation. Recent experimental evidence indicates that the presence of capillaries can influence adsorption not only in the high relative pressure region but also in the low relative pressure region. This discussion presents theoretical and experimental evidence of the effects of capillaries below the hysteresis loop for a series of carbon blacks and for a series of oxidized carbon blacks. (auth)

11489 A PRELIMINARY STUDY OF SURFACE OXIDE PRODUCED BY REACTION OF CARBON AND CARBON DIOXIDE. B. L. Tonge (General Electric Co. Ltd., Wem-

bley, Eng.). p.87-93 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Some preliminary experiments are reported on the formation and removal of surface oxide on carbon at temperatures below 600°C. The equilibrium constant and heat of reaction for the system $C_f + CO_2 \rightleftharpoons C(O) + CO$ are given for the case in which reactor grade graphite is the experimental material. The nature and stability of surface oxides on a number of carbons are discussed; the influence of surface oxide on carbon gasification rates, nitrogen surface areas, and the gas contents of carbons is outlined. (auth)

11490 THE GASIFICATION OF CARBON IN CARBON DIOXIDE AND OTHER GASES AT TEMPERATURES ABOVE 900°C. T. H. Blakeley (Morgan Crucible Co. Ltd., London). p.95-105 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Reaction rates for the gasification by carbon dioxide of carbons ranging in reactivity from coconut charcoal to graphites show linear Arrhenius plots up to about 1100°C, above which diffusion starts to limit reaction rate. Gasification of carbon in oxygen or carbon dioxide is affected below 900° by "surface oxide," but this complex of carbon and oxygen has minor importance above 900°. Up to about 600° for oxygen, or 1100° for carbon dioxide, at low gas velocities (some hundreds of degrees higher for high gas velocities), over-all reaction rate is determined by chemical reaction rate, which in turn is chiefly controlled by type of carbon, temperature, and nature and partial pressure of gasifying gas. At higher temperatures, reaction rate is determined mainly by diffusion, and is governed by gas velocity and partial pressure. Transition between the two regimes normally covers 300° or more. (auth)

11491 ON THE ROLE OF SURFACE OXIDES IN THE GRAPHITE–OXYGEN REACTION. L. Bonnetain, X. Duval, and M. Letort (Faculté des Sciences, Nancy, France and Centre d'Études et de Recherches des Charbonnages de France). p.107-114 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Combustion rates of a graphite sample under controlled conditions are determined with only a very small consumption of the sample. After an initial degassing under vacuum at 950°C, the combustion rate at a constant pressure of oxygen (between 10^{-4} and 10^{-1} mm Hg) and at a constant temperature (between 400 and 700°C) decreases gradually as a function of the amount of burn-off until a steady value is reached. During the decreasing rate period, the rates of production of CO and CO_2 (these being primary products) are related by a linear relation ($V_{CO} = m_0 V_{CO_2} + b$). During the subsequent desorption of the surface oxides at the same temperature as the combustion, the ratio of CO to CO_2 collected becomes numerically equal to m_0 at the same temperature. The value of m_0 depends on the temperature, but is almost the same for three artificial graphites studied. The desorption rate decreases exponentially with the quantity desorbed, in accordance with Elovich law. The initial decreasing of the combustion rate is attributed to the gradual consumption of the very reactive carbon atoms left on the graphite surface by the departure of surface oxides. That analogous relations exist between the production rates of CO and CO_2 during the combustion and during the desorption shows that surface oxides as a whole participate in the reaction and that the evaporations of CO and CO_2 do not occur as independent processes. (auth)

11492 QUENCHED-IN LATTICE DEFECTS IN GRAPHITE. G[erhart] R. Hennig and M. A. Kanter (Argonne National Lab., Ill.). p.141-4 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Lattice defects introduced in graphite crystals by irradiation are identified even in low concentrations by the surface markings produced by catalytic oxidation. These defects facilitate the penetration of iron catalysts along the c-axis of the crystals heated in oxygen at 700°C, thus producing readily identifiable pits. The catalyst does not produce such pits in the absence of lattice defects. The lattice defect responsible for this effect is believed to be the vacancy. Heat treatment of graphite crystals is also found to have a marked effect on the mechanism of subsequent catalytic oxidation. Pit formation is observed in crystals which have been heated at 2300 to 2500°C or in those which were cooled slowly from higher temperatures. No pit formation is observed in crystals quenched from temperatures above 2700°C or in those found in nature and given no heat treatment. The kinetics of the process imply the presence of two kinds of lattice defects at high temperatures. (auth)

11493 ELECTRON MICROSCOPE STUDIES OF GRAPHITE SINGLE CRYSTALS. G[erhart] R. Hennig (Argonne National Lab., Ill.). p.145-54 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

A number of chemical reactions of graphite were examined by kinetic studies on single crystals and by simultaneous microscope and electron microscope studies of the surface structure. The reactions studied include reactions with CO_2, O_2, O_3, O, and a preliminary study of the sublimation process. For any one of these reactions, the effect of crystal perfection, previous heat treatment, previous neutron or γ irradiation, and partial annealing of the ensuing radiation effects were studied. Furthermore, the effects of catalysts and of inhibitors on each reaction were examined. Most of the electron microscope studies were carried out by shadowing and replicating the graphite crystals. A method was also developed of preparing plane parallel or wedge-shaped single crystal fragments sufficiently thin for direct examination in the electron microscope. Some observations related to dislocations and radiation damage in these were discussed. (auth)

11494 THE ENERGY EXCHANGE BETWEEN ARGON AND A HOT GRAPHITE SURFACE. L. Meyer (Univ. of Chicago). p.155-7 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

The energy exchange between cold argon gas and a hot graphite surface was measured. The amount of energy carried away by the argon atoms is proportional to the pressure in the range from 3 to 15 μ, independent of the temperature of the graphite surface ranging from 1100 to 1500°K, and inversely proportional to the temperature of the cell wall, i.e., the temperature of the atoms before striking the hot surface. The critical temperature T_c for the temporary adsorption of A on the graphite surface derived from these experiments is 780°K. Furthermore, it was established that the accommodation coefficient becomes 1 within the error of ±5% for temperatures of the graphite surface below 780°K, in accordance with the model of temporary physical adsorption proposed for the exchange mechanism. (auth)

11495 RETENTION OF PROTONS BY GRAPHITE. George L. Montet (Argonne National Lab., Ill.). p.159-64 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

An investigation of some of the interactions of the hydrogen–graphite system was carried out. It was found that it is possible to cause massive graphite to take up hydrogen if the graphite is made the cathode in a glow discharge. The amount of hydrogen taken up is a function of the temperature as is the rate of evolution of hydrogen from hydrogen-impregnated graphite. The activation energy for the movement of hydrogen through graphite was found to be 13 kcal. The proton bombardment associated with the discharge causes graphite to sputter. No systematic study of the sputtering was undertaken, but it was observed that the sputtered carbon readily combines with hydrogen to form simple hydrocarbons. Attempts were made to ascertain if the hydrogen driven into the graphite forms a lamellar compound. No permanent change in the electrical properties of graphite has been detected, and magnetic resonance studies indicate that the hydrogen is not present in its atomic state. However, these results are not conclusive evidence against the formation of a lamellar compound. (auth)

11496 TERNARY LAMELLAR COMPOUNDS OF LITHIUM OR SODIUM WITH GRAPHITE. Marceline L. Dzurus, Gerhart R. Hennig, and George L. Montet (Argonne National Lab., Ill.). p.165-8 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Lamellar compounds of graphite are formed by potassium, rubidium, and cesium. Some doubt exists as to whether lithium and sodium can also form such compounds with graphite. Considerations of the energy of formation indicate that neither of these two substances should form concentrated lamellar compounds with graphite. It was found that very pure sodium does not appear to react with graphite at temperatures up to 450°C. Reactions can be promoted, however, by small amounts of impurities such as sodium hydroxide, sodium oxide, barium oxide, and ammonia. It is believed that the impurities occupy so-called "spacer" positions in the lattice and thus facilitate the intercalation of sodium. It seems likely, however, that very low concentrations of impurity act as catalysts. Experiments with lithium seem to indicate that it will also react with graphite only when impurities are present. (auth)

11497 ACCEPTOR AND DONOR IMPURITIES IN GRAPHITE. Gerhart R. Hennig (Argonne National Lab., Ill.). p.221-6 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Five different types of impurities or defects which affect the electron distribution in graphite are known. These are ordered and disordered interstitial chemical impurities, substitutional impurities, radiation-induced disorder, and quenched-in vacancies. Ordered interstitial chemical impurities (lamellar compounds) were introduced and studied in polycrystalline and in single crystal graphite. Disordered interstitial impurities (residue compounds) were studied only in polycrystalline graphite. Substitutional impurities were introduced in both polycrystalline and single crystal graphite, but only one impurity, boron, has been studied thus far. Effects of radiation were studied in detail, but are complicated because various different centers are present. Vacancies or other lattice defects can apparently be introduced even in single crystals by quenching from high temperatures. (auth)

11498 ON THE MECHANISM OF THE CARBONIZATION OF BENZENE, ACETYLENE AND DIACETYLENE AT 1200°C. C. R. Kinney and R. S. Slysh (Pennsylvania State Univ., University Park). p.301-13 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

When benzene is pyrolyzed at 1200°C at a concentration of 0.1 mole % in helium and at very short contact times, the primary decomposition products, stable at room temperature, are mainly acetylene, diacetylene, and hydrogen. This conclusion suggests that the benzene ruptures to give a six-carbon open-chain product which stabilizes by splitting into two- and four-carbon fragments. These appear in the final gaseous products as acetylene and diacetylene. Quantum-mechanical calculations support this experimental observation, although no six-carbon open-chain product could be isolated. Carbon is produced by the secondary reactions of acetylene and diacetylene, or more likely their free-radical precursors. This seems inescapable because there is a direct relationship between the decrease in the amount of acetylene and diacetylene coming out of the hot zone and the amount of carbon deposited. No doubt other decomposition products contribute to the structure of the carbon produced, and perhaps introduce many of the irregularities observed in carbons from different sources, particularly surface growths. The formation of whiskers seems to characterize the pyrolysis of acetylene, under the conditions used, while the production of soot characterizes the decomposition of diacetylene. The greater rate of decomposition of the latter hydrocarbon probably accounts for the vapor phase nucleation in this case. Benzene, which gives both acetylene and diacetylene, produces no whiskers or soot, only film or surface carbon. (auth)

11499 DISLOCATIONS IN GRAPHITE. A. Grenall and A. Sosin (Atomics International, Canoga Park, Calif.). p.371-402 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Transmission electron microscopy revealed the presence of dislocations in graphite. The nature of these dislocations and their movement within the crystals were studied and recorded by motion pictures. The techniques employed are described. Thermal stresses set up by the electron beam are believed responsible for the driving force producing dislocation motion. The relationship between dislocation formations and the microstructure of graphite is shown. A description is given of the directions and magnitudes of Burgers vectors, dislocation axes, and slip systems with regard to the structure. Theoretical consideration was made of dislocation line width in graphite and several metals and comparison made with experimental results. Line width is determined mainly by the ratio of the shear of Young's modulus. Illustrations, taken from the motion pictures, are given of single dislocations occurring within crystal grains, sub-grain boundaries, dislocation networks, and a generating source. (auth)

11500 GRAPHITIZATION STRESSES AND DISLOCATIONS IN POLYCRYSTALLINE CARBON. T. Tsuzuku (Nihon Univ., Tokyo). p.403-16 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

When a polycrystalline carbon is heat-treated, large thermal stresses are produced due to the interference of the anisotropically expanding crystallites. The stresses of this kind are expected to promote the rearrangement of the crystallites from the so-called turbostratic structure to the tri-dimensional graphite lattice, and so they may be adequately called "graphitization stresses." The stress analysis is carried out for each of the spherical and the cylin-

drical (filamentarily textured) polycrystals in which the carbon crystallites are aligned with basal planes parallel to the external surface. These two models approximate the structure of carbon black particles and of fibrous soft cokes, respectively. It is shown that in either of these two cases tension of about 3×10^{10} dyn/cm^2 in α-direction and compression of about 0.9×10^{10} dyn/cm^2 in c-direction can be produced at 2600°C, which are sufficient to buckle the crystal lattice at stress concentrations of 10 to 30 times and can lead to the formation of dislocations. From the corresponding strain distribution curves, the critical size of the crystallite containing the stable dislocations was determined, which is closely related to the differentiation between the so-called soft and the hard carbons. Furthermore, the mechanism of graphitization (crystallite growth), accompanied by the formation of dislocations at the intercrystallite boundaries, is discussed. These dislocations are expected to behave in such a way as to release the graphitization stresses. (auth)

11501 CRYSTALLOGRAPHIC AND PHYSICAL CHANGES OF SOME CARBONS UPON OXIDATION AND HEAT TREATMENT. W. V. Kotlensky and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). p.423-42 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Eleven commercial carbon blacks, one anthracite, and three graphites were studied. Changes in the crystallographic and physical properties upon oxidation and heat treatment were followed by measurements of helium densities, nitrogen low-temperature adsorption surface areas (BET), crystallite sizes, and average range of inhomogeneities and surface areas calculated from small-angle x-ray scattering data. On the basis of their change in properties, the carbons can be classified into two main groups. Group one carbons show a large decrease in helium density and BET surface area and an increase in particle density upon heat treatment, indicating the production of an extensive closed-pore system. Group two carbons show an increase in helium and particle densities and a very slight decrease in BET surface area upon heat treatment, indicating the development of a dense, compacted particle structure. The x-ray surface areas and average range of inhomogeneities for the carbons are compared with the BET surface areas and crystallite dimensions, respectively. (auth)

11502 STUDIES OF THERMAL CONDUCTIVITY OF POLYCRYSTALLINE GRAPHITE AT HIGH TEMPERATURE. Howard E. Strauss (Univ. of Buffalo). p.473-81 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

An apparatus was constructed for determining the thermal conductivity of graphite at temperatures from 1200 to 3000°C and at pressures varying from slightly above atmospheric to reduced pressures of high vacuum. Allowance for thermal expansion of the test specimens was provided, thus eliminating any loading stresses within the rod. No excessive sublimation of the graphite at the elevated temperatures, preventing measurements under low pressures, was experienced. A good reproducibility in successive runs was obtained. In the high temperature range, the thermal conductivity of porous graphite was found to be pressure-dependent—a decrease in conductivity was found as the pressure of the gas (nitrogen or argon) in the test chamber was reduced. The thermal conductivity and the electrical resistivity of graphite made from various carbon materials were determined in the temperature range of 1000 to 3000°C. (auth)

11503 THE MECHANICAL STRENGTH OF PYROLYTIC GRAPHITE. R. J. Diefendorf (General Electric Research Lab., Schenectady, N. Y.). p.483-8 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Pyrolytic graphite may be fractured in three mechanically different directions by transverse bend testing. The strength and its temperature coefficient from 90 to 1300°K were measured in the two strong directions, and the strength was found to be essentially constant at 23,000 lb/sq in. over the whole temperature range. It was also found that the strength for one of the strong orientations is weaker in air than in vacuum. A tentative explanation of this atmosphere effect is suggested. (auth)

11504 OBSERVATIONS ON THE HIGH-TEMPERATURE ELASTIC AND INELASTIC PROPERTIES OF POLYCRYSTALLINE GRAPHITES. Leon Green, Jr. (Aeronutronic, Newport Beach, Calif.). p.497-509 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

A comparison of the high-temperature strength and elastic properties of polycrystalline graphites with those exhibited by certain crystalline and amorphous materials indicates defects in the mechanisms postulated by Mrozowski and Hove to explain the temperature dependence of these properties. An interpretation of the elastic and inelastic properties of a polycrystalline graphite in terms of its polymeric nature is advanced, and experimental data obtained at the Aerojet-General Corporation are cited in support of this surmise. The relative magnitudes of activation energies derived from creep and relaxation measurements in the temperature range 2000 to 2800°C on a commercial molded graphite stock, using specimens with axes either perpendicular or parallel to the grain, indicate that the high-temperature plasticity of the material may result principally from shear strains in the crystallites parallel to the basal plane of the lamellae. The fact that the gross average magnitude of these activation energies is of the order of one-half the value reported for lattice self-diffusion in graphite suggests that the rate of creep or relaxation in this temperature range may be controlled by the movement of peripheral atoms at the crystallite boundaries to permit breaking and making of C—C bonds. The results of repeated transient creep tests in tension and torsion indicate that the plastic behavior may be strongly influenced by strain history. Preliminary strength measurements on boron nitride at temperatures from 1000 to 2400°C confirm the trend suggested by data obtained at lower temperature in that the strength increases with temperature in this range. (auth)

11505 HIGH TEMPERATURE PHYSICAL PROPERTIES OF MOLDED GRAPHITES. H. H. Lund and S. A. Bortz (Illinois Inst. of Tech., Chicago). p.537-46 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Properties of molded graphites were measured to temperatures exceeding their creep thresholds. These properties include thermal expansion, flexural dynamic and static modulus of elasticity, flexural strength, and tensile strength. The equipment and methods for measurement are briefly described, and data are presented for typical graphites. (auth)

11506 THERMAL EXPANSION OF PITCH BONDED CARBONS. J. Okada (Tokai Electrode Mfg. Co., Tokyo). p.547-52 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

The results of experimental studies of the dependence of the thermal expansion on the binder proportion, the size distribution in the coke filler, the type of binder pitch, the calcination temperature of the coke filler, and the influence of low-temperature oxidation are reviewed and discussed. Considering that the binder pitch impregnates the surface region of coke filler particles to some depth, and, when coked, creates a region with a thermal expansion differing from either the non-impregnated region of coke and from the ordinary binder coke formed between the filler particles, an explanation of the observed correlations is proposed. (auth)

11507 DEPENDENCE OF THERMAL EXPANSION OF BONDED CARBONS ON THE HEAT-TREATMENT TEMPERATURE. Jun Okada (Univ. of Buffalo). p.553-8 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Samples of four types of carbon were prepared from soft coke filler and soft binder, soft filler and hard binder, hard filler and soft binder, and hard filler and hard binder; these are heat treated to different temperatures in the range 500 to 3000°C. The average thermal expansion in the range from room temperature to 200°C was determined using a dilatometer with a Linear Variable Differential Transformer and an appropriate electronic circuit. The obtained curves show a decrease during baking, a hump around 1200°C, and a decrease or a respective increase in the higher temperature range. Information about the difference in the behavior of the soft and hard carbons and about the relative contribution of the filler and the binder to the thermal expansion is extracted from the data obtained. Curves of volume shrinkage vs. heat-treatment temperature are also presented for the four types of carbon rods. (auth)

11508 ELASTIC CONSTANTS AND PERMANENT SET IN CARBONS AND GRAPHITE AT ROOM TEMPERATURE. J. F. Andrew, Jun Okada, and D. C. Wobschall (Univ. of Buffalo). p.559-75 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

The room-temperature elastic constants and permanent set for several types of carbons were measured as a function of heat-treatment temperature. A sensitive apparatus using linear variable differential transformers was developed for measuring elastic moduli in bending and torsion in which the specimen can be stressed in either of two opposite directions. It was found that the dependence of Young's modulus and rigidity modulus on heat-treatment temperature is similar. Hysteresis loops were observed in both force-deflection and torque-twist measurements; the second and third loops becoming progressively more narrow. Annealing the specimen at 1000°C for a few minutes was found to restore the virgin behavior. Crackling noises were detected when carbon specimens were strained for the first time beyond the limits of previous deflection. Room-temperature creep was observed, which depends logarithmically on time, showing the absence of viscous creep. (auth)

11509 AN INTERPRETATION OF THE MECHANICAL BEHAVIOR OF CARBONS. H. W. Davidson and H. H. W. Losty (General Electric Co. Ltd., Wembley, Eng.). p.585-91 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

A consistent interpretation of the elastic properties of carbon and graphite was reached. In brief, it is thought that graphite accommodates impressed stresses by way of resolved relative movement of the layer planes which make up the crystal structure of all carbons. This view explains the following phenomena: the effect of neutron irradiation on elastic moduli; the effect of impregnation and heat treatment on carbons; the elastic moduli and their temperature coefficients for a variety of graphites; the high-temperature creep properties of a variety of graphites; and the elastic hysteresis and dynamic damping (at low frequencies) of carbons and graphites before and after heat treatment and neutron irradiation. The application of these views to an understanding of the strength of carbons and graphites is considered. (auth)

11510 THE PROBLEMS RAISED BY THE INFLUENCE OF NEUTRON IRRADIATION ON THE STRESS–STRAIN RELATIONSHIPS OF GRAPHITE. H. H. W. Losty (General Electric Co. Ltd., Wembley, Eng.). p.593-7 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

It is known that the elastic moduli of graphite increase as a result of neutron irradiation. A novel problem arises when graphite is irradiated stressed (or strained) and the stress–strain behavior is examined. This can be illustrated by considering a spring supporting a free weight. One can visualize two extremes of behavior: on the one hand the change in modulus causes the weight to be lifted while on the other hand, the weight remains stationary but a permanent set is observed on removal of the weight. Furthermore, irradiation may induce some degree of "plasticity," which will result in a relaxation of strain (or stress). The available experimental evidence was examined in this new light and the existence of an irradiation-induced plasticity is clearly demonstrated. The simplest interpretation of the effects suggests that the weight will not be lifted but will sag at a rate independent of the temperature. It appears that ungraphitized carbon deforms more rapidly than graphite. These conclusions support the view that irradiation shrinkage is a manifestation of this irradiation-induced plasticity. (auth)

11511 HIGH TEMPERATURE RADIATION INDUCED CONTRACTION IN GRAPHITE. J. M. Davidson, E. M. Woodruff, and H. H. Yoshikawa (General Electric Co., Richland, Wash.). p.599-605 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

High-temperature radiation-induced contraction of physical dimensions was observed in graphite samples irradiated above 300°C. At 400 to 500°C four types of graphite, KC, SGBF, CSGBF, and CSF, in order of decreasing structure development and aeolotropy, display contractions at 5000 Mwd/AT ranging from 0.00% for KC to 0.06% for CSF. However, the rate of contraction as a function of exposure is positive for all four types at 5000 Mwd/AT. High-temperature graphite irradiations at 600 to 1050°C are in progress at the Materials Testing Reactor and preliminary results indicate contractions ranging from 0.13 to 1.0% for integrated fast fluxes (>1 Mev) of 1.9×10^{20} and 2.6×10^{20}, respectively. An attempt has been made to relate these irradiations to Hanford equivalent damaging exposures. A model involving the production of vacancies and mobile interstitials by high-energy carbon atoms is suggested in explanation for this contraction. (auth)

11512 SYNTHETIC BINDERS FOR CARBON AND GRAPHITE. C. H. Riesz and S. Susman (Illinois Inst. of Tech., Chicago). p.609-23 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Studies of synthetic binders were conducted to obtain carbon bodies of controlled physical properties. A large number of resins were screened by means of a modified carbon residue procedure and three thermo-setting resins appear outstanding—phenol formaldehyde, phenol benzaldehyde, and furfuryl alcohol. Green carbons were prepared from Texas Lockport No. 90 petroleum coke flour with various synthetic binders, as well as Barrett No. 30 medium coal tar pitch. Various molding techniques were designed and applied to specific systems. Samples were first baked under an inert atmosphere to a temperature of 1000°C in a six-day cycle and then subjected to graphitization conditions at ~2800°C. Electrical resistivity, bulk density, and pore-size distribution measurements were obtained. Point probe electrical resistivity measurements indicated considerable internal variations within a given sample. Bulk density measurements showed widely different shrinkage behavior with the various binder systems. Pore size measurements demonstrated the unique behavior of the synthetic binders in achieving high real density, particularly for the furfuryl alcohol resin. The utilization of synthetic resin binders for producing carbons or graphites of controlled or superior physical properties is discussed. (auth)

11513 THE DEPENDENCE OF THE PROPERTIES OF GRAPHITE ON POROSITY. J. M. Hutcheon and M. S. T. Price (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.645-56 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

The effects of separately introduced variations in the manufacturing conditions on the technical properties of graphite were examined. The variables considered are binder content, number of impregnations, and extrusion conditions, and their effects on density, permeability, electrical resistivity, thermal conductivity, thermal expansion, and mechanical strength are measured. Processes which increase the density by modifying the macropore structure also increase the strength and thermal conductivity and reduce the electrical resistivity and air permeability as expected. It is shown that, provided other variables are held constant, systematic relationships exist between various technical properties and suitable voidage characteristics. (auth)

11514 THE EFFECT OF IMPREGNATION AND HEAT TREATMENT ON THE PHYSICAL PROPERTIES OF GRAPHITE. H. H. W. Losty (General Electric Co. Ltd., Wembley, Eng.). p.671-4 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

A new process of impregnating graphite with sugar solution was developed for the purpose of reducing its permeability to gases. The effect of this nongraphitizing impregnant on the physical, mechanical, and thermal creep properties of the graphite is considered. The data can be rationalized on the existing theory that the elastic and plastic deformations of graphite are accommodated within the structure by relative motions of the layer planes within the crystallites. (auth)

11515 THICKNESS GAGE FOR MEASURING THE DENSITY OF GRAPHITE. P. Leveque, M. Gasnier, R. Hours, G. Jouquet, J. Rappeneau, and J. C. Tanguy (Centre d'Études Nucléaires, Saclay, France). p.683-6 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960. (In French)

A thickness gage was built, based on absorption of Bremsstrahlung generated in a beryllium target by a $(Sr^{90} + Y^{90})\beta^-$ source. This allows rapid and precise estimation (95% probable error = 0.7%) of the densities in slabs of graphite having a constant thickness of 25 ± 0.05 mm, the diameter of the beam being about 1 cm. Results obtained in this way are presented. (auth)

11516 FINE GRINDING OF ARTIFICIAL GRAPHITE. J. R. May and R. K. Warner (Australian Atomic Energy Commission, Lucas Heights, New South Wales). p.741-50 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Homogeneous dispersions of fissile and fertile material in graphite are being currently considered as fuel for high-temperature gas-cooled nuclear reactors. A possible method of fuel preparation involves compaction of finely ground artificial graphite with uranium and thorium metal powders. Size reduction of artificial graphite is therefore of interest in the preparation of graphite-fuel compacts. Reactor graphite is successively size reduced in a jaw crusher, pin disk mill, and ball mill to give a material 50% finer than 9 μ, and with a BET nitrogen adsorption surface area ranging up to 18.4 m^2/g. The variables in ball milling are studied, and in particular it is found that nickel-hard balls give a faster grinding rate but a higher contamination than that obtained with steel balls. Leaching with boiling HCl is effective in removing contamination introduced by these grinding media. The Rosin–Rammler function, $R = 100e^{-(x/\bar{x}_n)}$ is applied to the size distributions of the ground graphite. In the size range 70 to 1000 μ the distribution constant n equaled 1. However, above and below this size range, n approximated 2. This high value of n for the subsieve range is not peculiar to artificial graphite as other materials were found to have a similar value of n. (auth)

11517 PROPERTIES OF MOLDED CEYLON NATURAL GRAPHITE. Frank Rusinko, Jr. and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). p.751-61 of "Proceedings of the Fourth Conference on Carbon held at the University of Buffalo, Buffalo, New York." New York, Pergamon Press, 1960.

Micron-sized Ceylon natural graphite (having an ash content of 2.1%) was molded into cylinders 1 in. long by ½ in. in diameter to apparent densities ranging from 1.61 to 1.99 g/cm^3. Subsequently, molded samples were heat treated at temperatures between 1556 and 3017°C. The specific surface area of the powdered graphite decreased from 11.6 to 8.5 m^2/g upon going from the original to the 2800°C heat-treated material. Molding, even to a density of 1.99 g/cm^3, resulted in a negligible decrease in the specific surface area, as measured by low-temperature gas adsorption. Heat treatment at a series of temperatures up to 3017°C resulted in a gradual decrease in the subsequent reactivity of the molded graphite to carbon dioxide. At a reaction temperature of 1000°C, the reactivity decreased from 1.32 g/hr for the original graphite to 0.048 g/hr for the material heat treated to 3017°C. For the original and 2600°C heat-treated samples, reactivity to carbon dioxide was determined from 900 to 1100°C. Reactivities (g of carbon reacting/hr × atm CO_2 × m^2 of carbon surface) were $1.5 \times 10^5 e^{-42,000/RT}$ and $1.7 \times 10^4 e^{-42,000/RT}$, respectively. Additional properties of the molded samples which were determined include radial and longitudinal density distributions, hardness, crushing strength, macropore volume distribution, and electrical resistivity. (auth)

11518 IMPROVEMENTS IN OR RELATING TO PROCESSES FOR THE PRODUCTION OF GRAPHITE. Hugh Wilson Davidson (to General Electric Co., Ltd.). British Patent 860,342. Feb. 1, 1961.

A method is given for producing graphite of very low permeability to gases. In this method, a dispersion of cellulose is formed, broken down in aqueous medium ($ZnCl_2$ solution or water itself), regenerated, heated to form carbon, and finally graphitized at 2500 to 3000°C. (D.L.C.)

11519 IMPROVEMENTS IN OR RELATING TO PRODUCTION OF URANIUM METAL. James Elgie Lloyd (to United Kingdom Atomic Energy Authority). British Patent 860,486. Feb. 8, 1961.

The method of producing uranium metal by reduction of UF_4 with magnesium, as given in Patent No. 780,974, can be improved by adding a small amount of trichloroethylene to the mixture prior to pelleting and reduction. This improvement consists of reduced slag inclusions and general cleanliness. Possible reasons for the improvement are given. (D.L.C.)

11520 IMPROVEMENTS IN OR RELATING TO THE ELECTROLYTIC PRODUCTION OF TITANIUM AND ZIRCONIUM. (to Sobertiz, Societe de Brevets, D'Exploitations et de Recherches Metallurgiques). British Patent 860,786. Feb. 8, 1961.

A process is given for the electrolytic refining of an alloy of titanium or zirconium containing at least one of the metals Al, V, Mn, Cr, or Fe. In this process, an electric current is passed through the electrolytic cell having a soluble anode of the alloy, a cathode, and a molten electrolytic bath which contains one or more alkali or alkaline earth metal salts and a subhalide of titanium or zirconium. Additions of fresh alloy to the anode are made periodically during the electrolysis. Examples are given illustrating the application of this method to titanium alloys. (D.L.C.)

Corrosion

11521 (ARF-2198-11) IMPROVED ZIRCONIUM ALLOYS. Quarterly Report, October 1, 1960–December 31, 1960. D. Weinstein, F. C. Holtz, and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 2, 1961. 8p. Contract AT (11-1)-578. Project Agreement No. 1.

Corrosion studies were made on several binary and ternary zirconium alloys in 680°F water after 168 and 355 hr exposure. The binary compositions included zirconium with 0.25 to 3 wt.% Fe, Co, Ni, Cu, Cr, W, Mo, Ta, Te, Si, Ge, As, Bi, Pb, Pt, Pd, Rh, Ag, Au, In, or Y; 0.5 to 75 wt.% Nb; 0.5 to 20 wt.% Sn; 0.25 to 9 wt.% V; and 0.25 to 10 wt.% Sb. The ternary compositions included Zr–25 Nb–1(Sn, Sb, Cr, V, Fe, Cu, or Pd). (B.O.G.)

11522 (KAPL-2052) THE APPLICATION OF INFRARED TECHNIQUES TO THE STUDY OF THE CORROSION FILM ON ZIRCALOY. H. A. Fisch, C. A. Kindness, and F. P. Landis (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 5, 1959. Contract W-31-109-Eng-52. 16p.

Corrosion films resulting from exposure of Zircaloy-2 and Zircaloy-3 coupons to 680°F water and 750°F steam were investigated by infrared absorption techniques to determine the presence of OH in the film. Since no absorption at the OH stretching frequency, 2.9μ, was found in the film, it is tentatively concluded that OH is not present. Infrared absorption spectra for both anhydrous and hydrated ZrO_2 were measured in the range 2 to 26μ. The characteristic absorptions for anhydrous ZrO_2 occurred at 13.5, 17.5, and 19.6μ. The hydrated ZrO_2 showed bands at 3, 6.4, and 7.5μ. The variation in the intensity of absorption at the 3μ band with the composition of the hydrate indicates that a quantitative analytical procedure for ZrO_2 hydrates may be developed. (auth)

11523 (MND-E-2012) ERDL-NPFO QUARTERLY PROGRESS REPORT NUMBER FOURTEEN ON METALLURGY FOR OCTOBER THROUGH DECEMBER 1960. (Martin Co. Nuclear Div., Baltimore). Jan. 1961. Contract DA-44-009-ENG-3581. 27p.

A series of 50-hr autoclave tests was performed on Monel and nickel specimens. The results, along with the results from the 200-hr tests, indicated that the corrosive attack of nickel substantially decreased after 200 hr of exposure, whereas the rate for Monel appears to be constant over the same time span. To further investigate the temporal behavior of the corrosion rate, a series of 2000-hr tests was initiated. A total of 614 hr of test time was accumulated in the first series. Testing of the bimetal model vessels (MOD SX-4) and the Inconel model vessels (MOD SX-7) was initiated. Approximately 510 hr of test time were accumulated. Testing of the bimetal miniature vessels (MIN 15 and 16) and the Inconel miniature vessels (MIN 10 and 11) was initiated. Approximately 510 hr of test time were accumulated. (For preceding period see MND-E-2011.) (auth)

11524 (ORNL-3056) EFFECT OF HEAT FLUX ON THE CORROSION OF ALUMINUM BY WATER. PART II. INFLUENCE OF WATER TEMPERATURE, VELOCITY, AND pH ON CORROSION-PRODUCT FORMATION. J. C. Griess, H. C. Savage, T. H. Mauney, J. L. English, and J. G. Rainwater (Oak Ridge National Lab., Tenn.). Feb. 27, 1961. Contract W-7405-eng-26. 40p.

The influence of water temperature, pH, and velocity on corrosion and on corrosion-product formation on the surface of aluminum alloys subjected to a very high heat flux was determined. At a heat flux of 1.5×10^6 Btu/hr·ft^2 and with cooling-water temperatures and velocities in the ranges of 131 to 223°F and 32 to 48 fps, respectively, a tightly adherent layer of corrosion products ($\alpha Al_2O_3 \cdot H_2O$) formed on the surface of the aluminum specimens at a linear rate during 10-day tests. The rate at which the corrosion product formed (and the rate of temperature increase in the aluminum) was markedly influenced by the pH of the coolant. With high-purity water as the coolant, oxide films as thick as 1.5 to 2.0 mils formed in 10 days. When the pH of the cooling water was adjusted to 5 with nitric acid, oxide films less than 0.5 mil formed under the same conditions. From measured oxide thicknesses and temperature drops across the corrosion-product films, a thermal conductivity of 1 Btu/hr·ft^2·°F/ft was calculated for the aluminum oxide film. The rate of oxide formation was independent of the alloy and the velocity in the range investigated. The temperature of the cooling water was a significant factor; the lower the water temperature, the slower the rate of film formation. Because of the manner in which the specimens were fabricated, quantitative corrosion measurements were not possible. However, it was qualitatively established that corrosion was not severe; and, except in one case, evidence of localized attack was not found. It was concluded that under the conditions expected to exist during operation of the High-Flux Isotope Reactor, aluminum would be a suitable material for cladding fuel elements. (auth)

11525 (CEA-tr-A-312) CORROSION ET PASSIVITE. (Corrosion and Passivity). U. F. Franck. Translated into French from Werkstoffe u. Korrosion, 9: 504-12(1958). 40p.

A review is presented of the corrosion and passivation of metals. In the present study only the corrosion of metals covered with a protective coating is considered. Passivation and corrosion as electrochemical phenomena are first discussed. The properties of passive layers are then described. The behavior of nonferrous metals with respect to corrosion is examined. 63 references. (J.S.R.)

11526 (CEA-tr-A-822) RECHERCHES SUR LE MECANISME DE L'OXYDATION DU FER PUR ET D'ACIERS FAIBLEMENT ALLIES. (Research on the Mechanism of Oxidation of Pure Iron and Low-Alloy Steels). H. J. Engell. Translated into French from Z. Elektrochem., 63: 835-45(1959). 39p.

An investigation on the distribution of defects in layers of wüstite revealed a linear relation for the concentration of vacancies. A relation of this type for the concentration of mobile defects in tarnish layers follows from Wagner's theory of tarnish processes, if the diffusion coefficient of the vacancies is independent of concentration, and if their activity is proportional to concentration. In wüstite this is approximately true. In growing wüstite tarnish layers, equilibrium exists at the phase boundaries between iron and wüstite and between wüstite and magnetite. It may be disturbed by cracks forming between the oxide layer and the metal. The causes of crack formation and the influence of cracks on the mechanism of oxidation are discussed. The influence of alloying elements in a concentration below 1% on the tarnishing of iron depends on their affinity to oxygen and on the reactions between their oxides and wüstite. These elements may be classified into three groups according to their mode of reaction and their influence on the kinetics of oxidation. Carbon is an exception because of its gaseous reaction products. An investigation on the oxidation of iron–carbon alloys shows that carbon oxidizes preferentially. Probably it reaches the gas phase by diffusing through the tarnish layer. Under certain conditions of experiment this diffusion may become rate determining for the decarbonization of the alloys. (auth)

11527 INFLUENCE OF ACID AND CHLORIDE CONCENTRATIONS ON CORROSION IN A NITRIC ACID CONCENTRATOR. J. B. Lowe (Eldorado Mining and Refining Ltd., Port Hope, Ont.). Corrosion, 17: No. 3, 26-8(Mar. 1961).

Experience with corrosion in a large concentrator used to recover nitric acid from raffinate waste products in a uranium refining plant is related. Solution of the corrosion problem in the concentrator involved generation of ozone by electrical discharge generators to oxidize chlorides to produce chlorine. An electrolytic cell also was used to remove chlorides. Chlorides concentrated in that portion of the tower where acid concentration was 20 to 30% necessitating frequent replacement of bubble caps and other parts. Areas subjected to high velocities had abnormally high corrosion rates. Results of tests on Hastelloy C, Carpenter 20, Ni-O-Nel, Incoloy, Inconel, and various stainless steels are tabulated for 25 to 35%, acid strength with 550 ppm chlorides and for 30 to 40% acid with 800 to 900 ppm chlorides. A corrosion profile of the concentrator from Trays 1 to 12 in both acid and vapor phases is given. Several conclusions are listed including one that chloride removal by electrolysis is not more efficient or less expensive than by ozonation until concentrations exceed 1000 ppm. The 18-8 series stainless suffered negligible corrosion up to 200 ppm chlorides, and tolerable rates when chlorides are below 600 ppm at low flow velocities. At chloride concentrations over 900 ppm, corrosion of 18-8 was excessive. (auth)

11528 BEHAVIOR OF STRUCTURAL MATERIALS IN A PRESSURIZED WATER REACTOR ENVIRONMENT. M. A. Cordovi (International Nickel Co., Inc., New York). Energia nucleare (Milan), 8: 51-61(Jan. 1961). (In English)

Some of the problems are discussed which can arise in PWR reactors from continuous contact of structural materials with hot pressurized light water in and outside a high neutron flux zone. The results of tests on the corrosion behavior of various materials in primary as well as secondary water are reported. The current status of studies concerned with the effects of irradiation on the mechanical properties of reactor structural materials also is reviewed. (auth)

11529 EFFECT OF DISSOLVED GASES ON OXIDE FILM FORMATION. J. J. Polling (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Electrochem. Soc., 108: 294-6(Mar. 1961).

In a study of the effects of metal hardness on the potential barrier at the metal-oxide interface, an unusual color effect was observed. Ten rectangular-shaped zirconium sheets, 0.125 mm thick and 7.5 × 2 cm sides, were stacked in an Al_2O_3 crucible at 800°C for 4 hr at 10^{-5} mm Hg. Upon cooling, the outer faces and edges of the stack had become brown, the characteristic color of a 5-volt anodic potential. A tentative theory was that gases were adsorbed from the vacuum system forming a solid solution; the temperature was then too low for fast diffusion. That the dissolution of O_2 alters the dimensions of the potential barrier has some support, but such a mechanism does not explain the lack of agreement of optical and capacitance measurements, unless the film is to some extent conducting. (T.R.H.)

11530 THE EFFECT OF HALIDE IONS ON THE ANODIC PASSIVATION OF ZIRCONIUM. Akimi Umezono and Susumu Morioka. Nippon Kinzoku Gakkai, 24: 680-4(1960). (In Japanese)

The effect of halide ions on the anodic passivation of zirconium in acid, neutral, and alkaline solutions was studied. In the presence of F^- ions, dissolution of zirconium was observed in acid solution and pitting corrosion in neutral solution, but in alkaline solution zirconium was not attacked. In the presence of Cl^- or Br^-, pitting corrosion of zirconium was observed in solutions of any pH value, but Cl^- pitting was prevented to some extent by the presence of NO_3^-, or NO_2^-, and that of Br^- by the presence of OH^- ions. Neutral iodide solution, without other oxyanions, pitted zirconium, but solutions containing other oxyanions caused no pitting. Oxidizing agents promoted the start of pitting, but general anions prevented the corrosive action of halide ions. The pitting corrosion potential did not vary with current density. A linear relation was found to exist between the pitting corrosion potential and the logarithm of the halide ion concentration. Halide ions caused a great number of smaller pits in the order of $Cl^- < Br^- < I^-$. (auth)

11531 ZIRCALOY–UO_2 FAILURES TIED TO FLUORIDES. M. J. F. Notley and J. A. L. Robertson (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucleonics 19: No. 3, 77-9(Mar. 1961).

Two pairs of defected Zircaloy-sheathed UO_2 fuel elements were irradiated in a pressurized water loop. The elements in each pair were identical except that the UO_2 in one contained 340 to 560 ppm of fluorine as CaF_2, whereas, the other had < 6 ppm. The specimens with the high fluoride content failed rapidly with extensive sheath cracking and hydriding, whereas the low-fluoride ones were virtually unchanged. Thus the hypothesis is confirmed that the reported failure of similar fuel elements in the Vallecitos Boiling

Water Reactor is due to the accidental high fluorine content found in the UO_2. (D.L.C.)

11532 ON THE REACTION OF IRON WITH KCl-$TiCl_2$ MELTS IN TITANIUM VESSELS. K. Blankenstein. Tech. Mitt. Krupp, 18: 9-18(Aug. 1960). (In German)

Experiments aiming at the preparation of titanium coatings on iron were made using the following experimental arrangement: titanium vessel, iron sample in salt melt containing Ti^{2+}-ions, and a protective atmosphere. Precipitation of titanium on sample surface and subsequent diffusion processes were studied. Multiphase diffusion in the phase sequence α-Fe$-$$Fe_2Ti-FeTi-\beta$-Ti$-\alpha$-Ti was found. Chemical and x-ray analyses of these phases were made. Evaluation of D_{Ti} and activation energy in α-(Fe, Ti) solid solution was carried out. Approximative calculation was made of D_{Ti} in the Fe_2Ti-phase. Microhardness and corrosion tests were performed. (auth)

11533 EFFECT OF CHLORINE ON THE CORROSION OF TITANIUM IN HYDROCHLORIC ACID. Kh. L. Tseitlin and V. A. Strunkin (Voroshilov Inst. of Organic Intermediates and Dyestuffs, [USSR]). Zhur. Priklad. Khim., 33: 2796-9(Dec. 1960). (In Russian)

In view of its great corrosion resistance titanium is much used in chemical technology but its resistance against inorganic acids is too low. It was found that the presence of free chlorine in HCl reduces considerably the rate of attack of titanium. At room temperature, titanium is resistant against all concentrations of the acid, if saturated with chlorine; it is stable up to 60°C against the 20% acid and up to 80°C against the 10% HCl saturated with chlorine. To guarantee the absence of attack on titanium, the acid must be repeatedly, or better continuously, saturated with chlorine. (TTT)

Fabrication

11534 (AD-242215) LITERATURE SEARCH ON ULTRASONICS IN WELDING AND OTHER ULTRASONIC JOINING PROCESSES. G. I. Chandler (Autonetics Div., North American Aviation, Inc., Downey, Calif.). Apr. 15, 1960. 30p. (EM-6059)

The 95 references in this bibliography are representative of the literature on ultrasonics in soldering, brazing, and welding processes. The abstracts are arranged by primary author for the year of publication and are followed by an author index. The literature search includes data from 1950 through March 1960. (auth)

11535 (AD-243448) FABRICATION OF BERYLLIUM FINE WIRE. Progress Report No. 2, June 1, 1960 to August 1, 1960. A. G. Gross, R. G. O'Rourke, and W. W. Beaver ([Brush Beryllium Co., Cleveland]). 13p. Contract NOas 60-6108-C.

The wire-drawing apparatus described previously was completed and tested, and is being altered to include a variable-speed drive on the capstan. Facilities for cleaning the wire were installed. Since the surface conditions of the wire were found to become more important as the diameter decreased, an investigation was made of surface preparation techniques to find a commercially feasible solution which would effectively dissolve beryllium while improving the plastic flow properties of the surface. The solution containing 0.3 wt.% HF and 15.4 wt.% HNO_3 in water was the preferred mix and performed better at 70°C than at room temperature. As-received sample diameters were measured at three different longitudinal positions. The measurements were repeated during pickling in the HF$-$$HNO_3$ solution at 70°C, and the times for various amounts of surface removal were recorded. It was concluded that this concentration, when used at 75 ± 5°C, produced a very uniform attack at a rate of ~0.005 in. of surface removal per minute. The treated wire was bend tested by making 180° free bends around mandrels of known diameter. Each specimen was wrapped on successively smaller mandrels until fracture occurred. The bend radii immediately preceding and at fracture were noted and were expressed as α, the ratio of the inside bend radius to the specimen diameter. The values of α are considered accurate to ±0.50. The test data are tabulated and given graphically as minimum bend radius as a function of stock removal. (B.O.G.)

11536 (AMFC-59-2) SOLID PHASE BONDING OF ZIRCALOY-2 BY RESISTANCE HEATING. T. Duff (AMF Atomics (Canada) Ltd., Port Hope, Ont.). Feb. 9, 1960. 24p.

An investigation was conducted to obtain information on solid-state bonds in Zircaloy-2 by resistance heating. Specimens of spot type joints were used to experimentally examine the parameters governing the process. Results are discussed and conclusions are listed. (J.R.D.)

11537 (APAE-73) WELDING 2-1/4% Cr$-$1% Mo STEEL TUBES TO 2-1/4% Cr$-$1% Mo STEEL TUBESHEETS. Final Report. (Alco Products, Inc., Schenectady, N. Y.). Aug. 15, 1960. 48p. Contract AT(11-1)-666.

The investigation reported presents the results of a program whose aim was the development of a reliable and reproducible procedure for welding tubes to tubesheets comprised of 2¼% Cr$-$1% Mo steel. Of the three basic types of welding processes evaluated, the inert-gas-shielded tungsten-arc (nonconsumable electrode) process proved to be the most applicable for welding these tubes to tubesheets. Compared to the inert-gas-shielded metal-arc and manual metal-arc processes, the superior applicability of the inert-gas-shielded tungsten-arc process was evident by the readily obtainable reproducibility in regard to uniformity and weld quality, as well as greater operator appeal due to the more easily controlled weld puddle. Weld quality with the tungsten-arc process was found to be appreciably influenced by such factors as base-metal-surface oxides, composition and size of welding wire, and welding current. Satisfactory results were obtained by thoroughly cleaning prior to welding the metal areas forming the joint, the use of a $^3/_{32}$-in.-diameter wire having a silicon content ranging from 0.34 to 0.50% and through the application of sufficient current to insure proper fusion and penetration. Because the metals involved are air-hardening and have limited ductility in the as-welded condition, various pre- and post-heat treatments were conducted to establish the most applicable combination to use, consistent with obtaining the maximum possible ductility as measured in terms of DPH hardness. Welding preheat-temperatures of 70, 200, and 400°F were evaluated followed by postweld heat treatments at 1325°F for periods of 1 and 6 hr. The 200°F preheat, selected for the final recommended welding procedure on the basis of hardness determinations, resulted in a maximum heat-affected zone hardnesses of 270 DPH after welding. Postweld heat treatments for 1 and 6 hr at 1325°F tempered this maximum hardness to 232 and 206 DPH, respectively. The 6-hr heat-treatment was necessary since the entire boiler section, of which the tube-to-tubesheet weldment is a component, was postheat treated as a unit. The result of a 6-hr time period at 1325°F was entirely satisfactory, as reflected in the 206 DPH value obtained. As a final reliability check, two prototype tube-to-tubesheet assemblies are currently being thermally fatigue tested. (auth)

11538 (CF-61-1-93) SUGGESTED FABRICATION PROCEDURES FOR ZIRCALOY-2 MILL PRODUCTS IN INGOT QUANTITIES. M. L. Picklesimer and P. L. Rittenhouse (Oak Ridge National Lab., Tenn.). Jan. 30, 1961. 11p.

Suggested fabrication procedures for Zircaloy-2 sheet, plate, rod, and bar are presented. The procedures are based on the physical and mechanical metallurgy of Zircaloy-2 and are designed to produce material with a minimum amount of preferred orientation, anisotropy of mechanical properties, and intermetallic stringers. The recommended procedures cover ingot soaking, fabrication, heat treatment, finish, workmanship, identification, and inspection. A brief discussion of the physical and mechanical metallurgy of Zircaloy-2 is presented. (auth)

11539 (DMIC-138) AVAILABILITY AND MECHANICAL PROPERTIES OF HIGH-STRENGTH STEEL EXTRUSIONS. R. J. Fiorentino and A. M. Sabroff (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). October 26, 1960. 66p. Contract No. AF 18(600)-1375. (PB-151097)

Information on the availability and mechanical properties of high-strength steel extrusions is compiled. Six classifications of high-strength steels are considered. Typical current extrusion specifications are discussed, and illustrative mechanical properties are reported. Some attention is devoted to anticipate future consumer requirements. (auth)

11540 (DMIC-143) HIGH-STRENGTH-STEEL FORGINGS. H. J. Henning and F. W. Boulger (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 5, 1961. 63p. Contract AF33(616)-7747. (PB-151102)

A report is presented on forgings made from martensitic steels heat treated to strengths ranging from 240,000 to 300,000 psi. Forging characteristics, design limitations, dimensional tolerances, and quality-control problems are discussed. A considerable amount of data on mechanical properties is also presented. The report also summarizes the available information on forged, semiaustenitic steels. (auth)

11541 (HW-66810) FABRICATION AND EVALUATION OF ZIRCALOY-2 AND ZIRCALOY-4 TUBING FOR USE IN CLADDING URANIUM DIOXIDE AND ALUMINUM–PLUTONIUM FUEL. P. L. Farnsworth and K. M. Haws (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1960. Contract AT(45-1)-1350. 17p.

Fuel elements for the Plutonium Recycle Test Reactor are clusters of 19 uranium dioxide or aluminum–1.65% plutonium alloy fuel rods clad with Zircaloy-2 or Zircaloy-4. High quality cladding is required to prevent in-reactor fuel-element failures. The quality of Zircaloy-2 and Zircaloy-4 tubing improved as test and inspection techniques capable of detecting defectives tubes were developed. An immersion ultrasonic test, capable of detecting defects as shallow as 0.002 in. on the inner tube surface, is promising. Observations of the behavior of tubing during swaging indicate that a small grain size is desirable if cracking is to be avoided. (auth)

11542 (KAPL-M-GIF-2) THE FABRICATION OF FIVE RARE EARTH METALS. THE MECHANICAL CONVERSION OF SAMARIUM, EUROPIUM, GADOLINIUM, DYSPROSIUM, AND ERBIUM TO SHEET. G. I. Friedman (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 15, 1960. 15p. Contract W-31-109-Eng-52.

The procedures used to convert cast ingots of Sm, Eu, Gd, Dy, and Er into 50- and 100-mil sheets are described. Fabrication temperatures, conditions, and precautions are given. Tables of oxidation rates and physical properties, which are pertinent to fabrication, are included. (auth)

11543 (NDA-Memo-2145-2) FEASIBILITY REPORT FOR NDA PLUTONIUM FACILITY. C. Bolta, comp. (Nuclear Development Corp. of America, White Plains, N. Y.). Mar. 22, 1960. 30p.

The procedures to be followed in preparing and developing plutonium-bearing fuel materials at the NDA Plutonium Facility are reported. The responsibilities of various personnel in the performance of their work are also listed. The project involves the fabrication and evaluation of plutonium and uranium carbides. (W.L.H.)

11544 (ORO-340) SYNTHESIS AND FABRICATION OF REFRACTORY URANIUM COMPOUNDS. Quarterly Report No. 5, August 1 through October 31, 1960. K. M. Taylor and C. H. McMurtry (Carborundum Co., Niagara Falls, N. Y.). Nov. 15, 1960. 10p. Contract AT(40-1)-2558.

Additional quantities of UC, UN, and U_3Si_2 were prepared to be used in fabrication of test specimens for property determinations. A reduction in oxygen contamination of UN and U_3Si_2 was achieved by improved techniques of synthesis. Preliminary values for thermal expansion, modulus of elasticity, and corrosion in boiling water were also obtained for these materials. (For preceding period see TID-6591.) (J.R.D.)

11545 (RFP-216) PREFERRED ORIENTATION IN CROSS-ROLLED URANIUM. G. R. Mallett (Dow Chemical Co. Rocky Flats Plant, Denver). Feb. 13, 1961. 41p. Contract AT(29-1)-1106.

A study was made of the preferred crystallographic orientation that occurs as a result of cross-rolling uranium sheet. The study was made by the use of inverse-pole figures and calculated thermal expansion coefficients. (auth)

11546 (TID-11750) EXTRUDED CERAMIC NUCLEAR FUEL DEVELOPMENT PROGRAM. Final Report. (Allis-Chalmers Mfg. Co. Nuclear Power Dept., Washington, D. C.). Jan. 23, 1961. Contract AT(11-1)-767. 45p.

Urania rods 6-in. long and 0.475-in. in diameter were extruded and sintered to densities exceeding 94% of the theoretical urania density. The rods dropped freely through a straight metal tube 8-in. long with an internal diameter 0.004-in. greater than the diameter of the rods. All properties of the extruded and sintered rods relevant to their use as a nuclear fuel material were at least equal to the corresponding properties of pressed and sintered urania pellets. Extruded and sintered urania rods can be produced with standard ceramic-industry machinery. From preliminary estimates it appears that extrusions may be produced more cheaply than pellets. (auth)

11547 (WAL-TR-401.54/1) FEASIBILITY OF BRAZING HIGH-STRENGTH SHEET TITANIUM. Joseph L. Sliney (Watertown Arsenal Labs., Mass.). Nov. 1960. 48p.

Fluxless brazing of commercially pure titanium and the all-β titanium alloy B-120VCA (Ti-13V-11Cr-3Al) is examined. A limited number of lap joints were induction brazed inside a bell jar, using argon at reduced pressure for protection during the heating cycle. The results obtained indicated that load-carrying ability of the joints increases with the length of overlap and with the strength of the base metal. Aging after brazing increases the joint strength by increasing the strength of the base metal. (auth)

11548 (AEC-tr-4415) PRINCIPLES OF THE THERMAL METHOD FOR THE PREPARATION OF BETA SOURCES WITH FUSED STRONTIUM^{90}. N. I. Bogdanov, K. P. Zakharova, P. V. Zimakov, and V. V. Kulichenko. Translated from Report No. RICC/326 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 22p.

Procedures are described for the preparation of Sr^{90} beta sources. A vitreous cast preparation was used based on the system $SrO-B_2O_3$, and thermal processing was employed. Data are tabulated on the melting point of mixtures of various compositions. Data are also tabulated on the specific activity of the preparations at various ratios of the components and on the basic radiophysical characteristics of the vitreous fused preparations based on Sr^{90}. The sources prepared by this method are reliable and safe to use, simple to prepare, have a high mechanical strength, are stable to heat and cold, are hermetic sources, and have many applications in the automatic control and regulation of industrial processes. (C.H.)

11549 (CEA-tr-R-524) EXAMEN DE L'ACIER LAMINE A UNE TEMPERATURE ELEVEE. (Examination of Steel Rolled at High Temperatures). K. V. Grigorov and G. P. Blokhin. Translated into French from Fiz. Metal. i Metalloved., 4: 470-3(1957). 11p.

A study was made of the effects of high temperatures during rolling on the texture of recrystallization of steel. Transformer steel (3% silicon) was used. The samples were heated to 500 and 600°C. After heating a fast rolling pass was made, then the specimens were reheated to the same temperature before the next pass, and so on until the desired degree of deformation was reached. After this procedure the specimens were air-cooled. For low-carbon steel (0.1%), the texture after rolling at 500° is near that of cold-rolled steel. The recrystallized semimild steel after rolling at 500° is similar to cold-rolled steel. The texture of steel rolled at 600° is stable in that it is unchanged by an anneal at 700 to 800°C. (T.R.H.)

11550 URANIUM MONOCARBIDE. G. A. Meerson, R. B. Kotel'nikov, and S. N. Bashlykov. Atomnaya Energ. 9: 387-91(Nov. 1960). (In Russian)

The optimum conditions in the fabrication of UC of stoichiometric composition are found. The sintering and hot-pressing of UC powder and sintering of UC + U-producing specimens with about 5% porosity are studied. The specific weight of UC determined pycnometrically is $12.97 \pm 0.09 g/cm^3$. The microhardness phase is $923 \pm 56 kg/mm^2$. The thermal conductivity of UC at 100 to 700°C varies from 0.028 to 0.04 cal /cm /sec /grad; the mean linear thermal expansion coefficient at 20 to 1500°C is 11.6×10^{-6}. The UC specimens under cyclic thermal treatment at 200 to 1000°C withstood 500 cycles; the specimens of UC + U withstood over 1000 cycles. (tr-auth)

11551 THE ARC-MELTING OF NIOBIUM, TANTALUM, MOLYBDENUM AND TUNGSTEN. A. R. Moss and D. T. Richards (Armament Research and Development Establishment, Fort Halstead, Kent, Eng.). J. Less-Common Metals, 2: 405-25(Dec. 1960).

An historical survey of the various methods used for arc-melting refractory metals is followed by a discussion on the modern arc-melting processes and techniques, including multiple-melting and semicontinuous casting. Detailed consideration is given to operating conditions in general, deoxidation practices, and methods of adding alloying elements. Particular attention is given to alloy segregation and other defects in ingots and to the means that may be adopted to overcome their occurrence. It is believed that the most satisfactory method of producing homogeneous high-purity ingots is to combine multiple-melting with the continuous-casting technique. (auth)

11552 DIRECT CASTING OF URANIUM MONOCARBIDE REACTOR FUEL ELEMENTS. W. M. Phillips, W. Chubb, and E. L. Foster (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals, 2: 451-7(Dec. 1960).

Procedures for preparing UC cast shapes with densities in excess of 98% of the theoretical density are described. In the first method, drop casting, uranium and crushed carbon are melted six times in a special carbon-electrode arc furnace in which the charge can be turned over after each 30-sec melting cycle. The carbon content of the 100 g UC button is homogeneous and controlled to ±0.1 wt.% carbon. This button is then cast in a second arc furnace into a graphite thimble mold. Castings up to $\frac{5}{8}$-in. in diameter by 3 in. in length and weighing 200 g can be made. In the second technique, charges of UC up to 8 kg are skull melted under vacuum or inert gas in a carbon-electrode arc furnace. Although good-quality castings (round, square, and hexagonal in cross section) can be made and are homogeneous to ±0.1 wt.% carbon, variation of carbon contents from melt to melt of ±0.3 wt.% carbon was noted. (auth)

11553 COLD-CRUCIBLE INDUCTION MELTING OF REACTIVE METALS. G. H. Schippereit (Battelle Memorial Inst., Columbus, Ohio), A. F. Leatherman, and D. Evers. J. Metals, 13: 140-3(Feb. 1961).

The possibility of induction melting reactive metals such as titanium was demonstrated to be technically feasible. A cold-crucible induction furnace was developed and demonstrated on a laboratory scale with titanium charges; no wetting or short-circuiting between crucible segments was observed. (D.L.C.)

11554 MANUFACTURE OF SINTERED BRICKS OF HIGH DENSITY FROM BERYLLIUM OXIDE. R. Pointud, Ch. Rispal, and M. Le Garec. Silicates inds. No. 2, 8p. (1959). (In French) (CEA-1234)

Beryllium oxide bricks of nuclear purity 100 by 100 by 50 and 100 by 100 by 100 mm of very high density (between 2.85 and 3.00) were manufactured by sintering under pressure in graphite molds at temperatures between 1750 and 1850°C, and under a pressure of 150 kg/cm^2. The physicochemical state of the saw material is of considerable importance with regard to the success of the sintering operation. In addition, a study of the sintering of a BeO mixture, with 3 to 5% of boron introduced in the form of boric acid, boron carbide, or elementary boron showed that high densities can only be obtained by sintering under pressure. For technical reasons of manufacture, only the mixture based on boron carbide was used. The sintering was carried out in graphite molds at 1500°C under 150 kg/cm^2 pressure, and bricks were obtained with density between 2.85 and 2.90. Laboratory studies and the industrial manufacture of various sinters are described in detail. (auth)

11555 METALLIZING NICKEL POWDER. W. B. Keyser (Goodyear Atomic Corp., Portsmouth, Ohio). Welding J. (N. Y.), 40: 229-31(Mar. 1961). (GAT-T-672 (Rev.1))

A program was established to study the feasibility of applying a corrosion-resistant coating to bare steel by metallizing nickel powder. Both the technique for preparing the base surfaces prior to metallizing and the metallizing techniques for applying a nickel coating were investigated. It was determined that a vacuum-blast machine serves as a suitable portable apparatus for preparing a metal surface for spraying, while a metal-spray gun accomplished satisfactory spraying of nickel powder. (auth)

11556 BRAZING OF BERYLLIUM FOR HIGH-TEMPERATURE SERVICE. S. R. Maloof and J. B. Cohen (Avco Corp., Wilmington, Del.). Welding J. (N. Y.), 40: 118-s-22-s(Mar. 1961).

By brazing with pure silver, joint strengths of 60% (30,000 psi) that of the base metal were obtained at room temperature. In the temperature range of 700 to 1450°F, the joint

strength was 80% that of the base metal. Twenty-four hour exposures in this range of temperatures did not affect the room temperature strength, if a continuous interface of silver in the joint was absent prior to exposure. Liquid silver spreads only partially on beryllium, apparently because of the liquid's rapid intergranular penetration. Because of this and the toxicity of beryllium fumes given off during a high-temperature braze, the silver should be preplaced or electroplated on the faces to be joined. Because of the rapid intergranular penetration of liquid silver into beryllium, elimination of the continuous interface of silver is readily accomplished by heat treatment during or after the brazing cycle. Intergranular penetration of silver into beryllium is not deleterious; a two-phase alloy consisting of beryllium primary particles surrounded by a silver matrix is ductile. Successful joints at all temperatures can in fact be made with a beryllium–20% (atomic) silver alloy, as well as with pure silver. (auth)

11557 COMPACTING METAL POWDERS WITH EXPLOSIVES. S. W. Porembka and C. C. Simons (Battelle Memorial Inst., Columbus, Ohio). Paper SP60-102 of "Creative Manufacturing Seminars, 1960-1961." Detroit, American Society of Tool and Manufacturing Engineers. 1960. 11p.

Some of the methods being used in preparing powder metal compacts by explosive techniques are described, and some typical results are discussed. A powder dispersion of 25 wt.% fused UO_2 in nickel was explosively compacted; the compact structure shows a very dense nickel matrix with fractures in the oxide particles. Tungsten powders explosively compacted gave 95% theoretical density. Compacting of Haynes Alloy No. 25, an alloy very hard to compact with conventional techniques, was performed successfully with 95% theoretical density, and stainless steel compacts prepared in this way gave 97.5% theoretical density. Some of the factors influencing explosive compacting of metals are discussed. It is concluded that explosive compacting will be useful in fabrication of large or complex shapes and compaction of metals not susceptible to conventional compacting methods. (D.L.C.)

11558 IMPROVEMENTS IN POROUS METALLIC MEMBRANES AND METHOD OF MANUFACTURING THEM. (to Commissariat à l'Énergie Atomique). British Patent 855,203. Nov. 30, 1960.

A method is given for manufacturing porous metallic membranes which are resistant to chemical corrosion. They are suitable for use as diffusion barriers in separation of uranium isotopes as UF_6 and in ultrafiltering in corrosive media. In this method, nickel or nickel oxide powder of average particle size (10 to 25 μ) is mixed with an organic agglomerating agent and the mixture rolled and sintered (sintering being carried out at high temperatures so that the agent decomposes without residue). The agent should be one of the group of halogenated hydrocarbon polymers, especially Teflon, and the mixing of the powder and agent should be carried out in the form of colloidal suspensions, using alcohol to flocculate the mixture to give a paste suitable for rolling and sintering. The sintering should be completed in a reducing atmosphere. An example of this method is given in which a membrane was obtained with a pore radius 0.06 to 0.20 μ and a permeability of 30 to 300×10^{-7} gram molecule/cm^2/min of air per cm of Hg pressure difference. (D.L.C.)

11559 IMPROVEMENTS IN OR RELATING TO METHODS OF DEPOSITING NICKEL–IRON FILMS. James Henry Stephen (to United Kingdom Atomic Energy Authority). British Patent 859,725. Jan. 25, 1961.

Methods of electrodepositing nickel(80%)–iron(20%) thin films having substantially rectangular hysteresis loops on cylindrical formers are described. Aqueous solutions of mixed nickel and ferrous sulfamates in which the ratio of nickel to ferrous ions was between 35 : 1 and 40 : 1 were used as the electrolyte. The cylindrical former served as the cathode, and the solution concentration was maintained substantially constant over its surface by rotating the cathode on its axis. The film thickness can be varied from 1000 to 10,000A, depending on the application. (M.C.G.)

11560 METHOD OF PRODUCING PERMEABLE MEMBRANES. (to Aktiebolaget Atomenergi). British Patent 860,099. Feb. 1, 1961.

A method of producing permeable membranes primarily intended for use in the separation of isotopes or gas mixtures by gaseous diffusion is described. Solid powder particles from which the membrane was to be produced were suspended in a gas. This suspension was then brought into contact with a close-meshed network in such a way that the particles deposit in a layer on one or both sides of the network. The network was then pressed and sintered together with the layer of particles to form a thin, strong membrane. The homogeneity of the powder deposit was improved by applying an electric voltage to the wire network. Preparation of aluminum oxide, aluminum nitride, and nickel membranes is described. (M.C.G.)

11561 IMPROVEMENTS RELATING TO PRESSURE VESSELS. Raymond Wallis Lakin and Sidney Howard Griffiths (to A.E.I.–John Thompson Nuclear Energy Co., Ltd.). British Patent 860,190. Feb. 1, 1961.

A pressure vessel designed for high internal fluid pressures is described. The vessel's main shell has a cylindrical side wall and hemispherical end walls which are continuous with the side wall. The walls are reinforced with banding which extends circumferentially around the exterior of the side wall and is joined by welding. A backing strip of suitable material is located underneath the joint to prevent adhesion of the band to the pressure vessel when welding takes place. (M.C.G.)

11562 PRODUCTION OF IRRADIATED POLYMER-COATED ELECTRIC CABLE. Solomon Harris Pinner and William Henry Thomas Davison (to T. I. (Group Services) Ltd.). British Patent 860,811. Feb. 8, 1961.

An economical technique is given for enhancing the properties of polymer-coated electric cables with radiation. This technique consists of applying a thin polymer layer (0.01-in. thick) onto the conductor, exposing the layer to an electron beam, applying another thin polymer layer, exposing this layer to the electron beam, and so on. In this way, a multilayered covering is built up which can be satisfactorily irradiated with low-energy electrons of low penetrating power. The polymer is preferably pure polyethylene, but related polymers which give similar improvements in their properties upon irradiation may be used. An unirradiated layer may also be included in the multilayered covering, e.g., a vulcanized neoprene coating. Possible industrial applications of this technique are discussed. (D.L.C.)

Properties and Structure

11563 (AD-235716) THE FORMATION OF OXIDE FILMS ON METALS. Quarterly Report No. 11 covering April 1 to June 30, 1959. L. Young, J. E. Orme, and L. Masing (British Columbia Research Council, Vancouver). 14p. Contract PE. 69-900100.

The formation and properties of oxide films are summa-

rized and the optical properties of anodic films are reviewed. Thickness of the films is determined by observing the wavelengths of minimum reflectivity at fixed angles of incidence. Reflectivity vs. angle plots indicate a larger index for films formed at 50°C in dilute acid and slightly lower and more variable values for films formed in 70 wt.% acid at 50°C. (J.R.D.)

11564 (AD-237955) HARD PARTICLE STRENGTHENING OF REFRACTORY METALS FOR HIGH TEMPERATURE USE THROUGH INTERNAL OXIDATION. Progress Report No. 3 [for] 1 November 1959–31 December 1959,. A. S. Bufferd, K. M. Zwilsky, and N. J. Grant (New England Materials Lab., Inc., Medford Mass.). Jan. 21, 1960. 10p. Contract NOas 59-6223-C.

The rate of oxidation of a Mo–0.5% Ti alloy was studied at 1200°F for times up to 100 hr as a function of oxygen pressure and degree of preheating of the gas phase. (C.J.G.)

11565 (AD-239292) DEVELOPMENT OF A NICKEL-BASE MATERIAL DISPERSION-HARDENED BY ALUMINA FOR 1600°F TO 2000°F SERVICE. Progress Report No. 7—January 7, 1960 through March 6, 1960. D. H. Feisel (Westinghouse Electric Corp. Research Labs., Pittsburgh). May 10, 1960. 22p. Contract NOas-59-6051-C.

The thermal stability of five dispersion-hardened alloys was examined by room-temperature hardness testing after exposure for various time periods at a number of elevated temperatures. With sufficiently severe combinations of exposure time and temperature, the alloys are softened. Hot-hardness and additional stress-rupture data are included. (For preceding period, see Report AD-239291.) (auth)

11566 (AD-240278) GRAIN SIZE EFFECTS ON THE THERMAL CONDUCTIVITY OF CERAMIC OXIDES. Progress Report No. 11, November 1, 1959 to April 30, 1960. (New York. State Univ. Coll. of Ceramics, Alfred). Contract AF33)616)-3798. 75p.

Sintering studies were conducted on several grades of magnesia by employing hot-pressing techniques. The raw materials used had less than ½% impurity. In several cases ½% LiF was added as a sintering agent. The results are discussed in terms of grain growth as a function of temperature and time of sintering. Density variations are also shown to indicate the degree of sinstering. High-purity dense fine-grained alumina specimens were used to study the effect of grain size on thermal conductivity. The thermal conductivity at 100 to 1000°C decreased in specimens below 10-μ average grain size with a maximum decrease in conductivity of 8% at 2 μ. The decrease in thermal conductivity with decreasing grain size was found to follow closely an additive reciprocal volume relation. The role of impurities in masking this effect in dense alumina samples greater than 99% pure was shown by measuring the thermal conductivity of specimens with small variations in impurity content. (auth)

11567 (AERE-R-3321) THE PURIFICATION OF BERYLLIUM METAL BY A DISTILLATION PROCESS. E. W. Hooper and N. J. Keen (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 23p.

Commercial beryllium metal was purified in gram quantities by a distillation process involving condensation in a heated tube, the temperature of which was graduated from 1300°C at the bottom to 900°C at the top. The interim results show that many of the impurities that are volatilized with beryllium pass to the cooler end of the condenser and the purest metal was collected in a zone of 1100 to 1000°C. The anomalous behavior of certain impurities is described. (auth)

11568 (AGN-8023) SPACE SYSTEMS TECHNOLOGY STUDIES; RUBIDIUM EVALUATION PROGRAM. Report No. 9. Quarterly Technical Report, August 1 through October 31, 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AT(04-3)-251. 95p.

The program was proposed (1) to provide data on the high-temperature corrosion of suitable containment materials by liquid and gaseous rubidium through static capsule and dynamic corrosion loop tests, and (2) to determine the latent heat of vaporization, specific heat, vapor pressure at various temperatures, and density of liquid rubidium from 1000 to 1800°F. The design, construction, and check-out of equipment was accomplished. A 316 stainless-steel corrosion capsule has operated at 1550°F for 50 hr and at 1800°F for 50 hr. The test results indicate that 316 stainless steel is an adequate containment material for short time exposures at temperatures approaching 1800°F and low stress levels. The loop system design is described and involves three complete loop systems: (1) rubidium loop with heater, cooler, pump, flow, and pressure control; (2) argon loop to cool the rubidium loop and to provide protection from oxidation for the loop components; and (3) a water loop to cool the argon loop. The loop control system is in the final stages of assembly. A description is given of the boiling apparatus and its operation for determining vapor pressures and the latent heat of vaporization. A method is discussed for measuring the rubidium level in the condensate reservoir using a gamma source and detector. An error analysis is given for the operation of the boiling apparatus for boiling heat input, volume of condensate reservoir, condensate reservoir fill time, and density of rubidium. The density measurement methods and apparatus are described. A method is given for determining the heat capacity of the liquid rubidium as a function of temperature in the corrosion test loop. (B.O.G.)

11569 (AMFC-60-5) STUDY OF THE STRUCTURE OF SINTERED URANIUM DIOXIDE FUEL PELLETS. D. S. Brearton (AMF Atomics (Canada) Ltd., Port Hope, Ont.). Feb. 29, 1960. 22p.

An attempt was made at studying and measuring the density gradient in sintered UO_2 pellets manufactured at AMF. The structure of these pellets when not fully densified made possible a method of counting areas of gross voids and relating the counts at different points within a pellet so that a gradient of density variations for the pellet could be constructed. This method is not an absolute method but it escapes the difficulties and errors involved in studies in conventional density determinations of small fragments of pellets. It was found that density gradients exist in the pellets. (auth)

11570 (ARF-2157-12) IMPROVEMENT OF HIGH-STRENGTH ALUMINUM CASTINGS. Final Report [for] August 27, 1958–August 27, 1959. C. Robert Lillie and Charles R. Simcoe (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 8, 1960. Contract DA-11-022-507-ORD-2890. 48p. (AD-240237)

Commercially available high-strength aluminum-base casting alloys containing approximately 10% magnesium suffer from a serious decrease in tensile ductility after being stored at room temperature for about a year. This program was aimed at determining the metallurgical processes which accompany such aging behavior, and at investigating compositional modifications which would aid in maintaining ductility by altering the product of aging and/or the kinetics of the reaction. Comparison of the aging behavior of a commercial Al–10 Mg alloy (No. 220 alloy)

and a high-purity Al–10 Mg alloy showed that the aging behavior of such alloys is relatively insensitive to variation in either solution treatment or cooling rate after solution treatment. The commercial 220 alloy overaged in 1000 hr only at an aging temperature of 180°C, while the high-purity alloy overaged in the same time period at aging temperatures of 80°C and above. There is evidence that the commercial 220 alloy may be stabilized against change in hardness due to room-temperature aging for times up to 1000 hr by preliminary aging at 80, 100, or 150°C. A second phase of this program concerned an investigation of compositional modifications of an experimental aluminum-base casting alloy, X-250. The X-250 alloy, containing 8% Mg, 1.5% Zn, 0.25% Mn, and 0.15% Cu, is reputedly nearly non-aging at room temperature. Evidence obtained from hardness-time curves for aging at 150°C indicates that the X-250 alloy ages more rapidly and to a greater extent than do alloys of the following novel compositions: Al-8 Mg-1 Mn-0.1 Ti-0.003 Be, Al-8 Mg-1 Cu-0.1 Ti-0.003 Be, and Al-8 Mg-2 Cr-0.1 Ti-0.003 Be. (auth)

11571 (ARF-2187-6) DUCTILE BERYLLIUM ALLOYS. Final Report, September 1, 1959–August 31, 1960. Frank A. Crossley and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Oct. 20, 1960. Contract NOas-60-6036-c. 46p.

An envelope type microstructure, prepared by liquid-phase sintering, was investigated as a means of producing ductile beryllium alloys. Ternary additions to Ca, Ce, Ge, La, Li, and Y were made to aluminum and silver matrix alloys to evaluate their effect in promoting sinterability. Germanium was effective in producing desirable two-phase structures. Macroporosity was eliminated in compacts containing 15% or less volume of matrix by sintering under a pressure of 1000 psi. Alloying beyond the ternary level was necessary in order to reduce the hardness differential between the beryllium phase and the much softer matrices. When such a hardness difference exists, fracture of the matrix occurs before significant flow of the principal phase, with the result that ductility is poor. Aluminum additions to silver matrix alloys were effective in increasing the matrix hardness. A cylindrical compact of nominal matrix composition Ag-6Al-3Ge was tested in uniaxial compression. Properties were as follows: yield stress (0.2% offset), 52,400 psi; true fracture stress, 97,000 psi; engineering fracture stress, 130,000 psi; total plastic deformation, 22%; modulus of elasticity, 22×10^6 psi; and density, 2.07 g/cc. The matrix content of this material was calculated from the density to be about 3% by volume. It modulus-to-density ratio is 2.9 times that of steel. (auth)

11572 (ARF-2200-9) THE BORON–CARBON SYSTEM. Quarterly Report No. 3, November 1, 1960–January 31, 1961. Rodney P. Elliott (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 6, 1961. Project Agreement No. 4. Contract AT(11-1)-578. 11p.

A definitive investigation of the boron–carbon equilibrium system is being made by x-ray diffraction, metallographic, and thermal analytical techniques. On the basis of metallographic and x-ray-diffraction studies it is concluded that boron carbide has a range of solubility from approximately 10 to 20 at.% carbon at 1500 to 2000°C. The melting point of the carbide-graphite eutectic was established as 2325 to 2350°C. No reversible allotropy of the β-rhombohedral structure was observed. The solubility of carbon in boron is very small. The melting point of dilute carbon alloys is found to be essentially the same as that of pure boron (2040 to 2050°C). No metallographic evidence of a three-phase reaction of dilute alloys is observed. (auth)

11573 (ARF-6046) SYNTHESIS OF REFRACTORY MIXED OXIDE WITH PEROVSKITE STRUCTURE. Final Report for the period May 24–November 24, 1960. Y. Harada and S. W. Bradstreet (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Nov. 22, 1960. 14p. Contract NOw 60-0235-c.

Experimental work on the preparation and measurement of $BaThO_3$ has shown: (1) The compound exists and is the most stable compound in the Ba-Th-O system; (2) it forms readily from a coprecipitated mixture of the barium and thorium oxalates at 750°C and the reaction is driven to completion below 1000°C in the presence of an excess of barium; (3) it is cubic at ordinary temperature, with the perovskite structure; (4) its lattice parameter is within the limits postulated by packing theory for consistent ionic radii, 4.497 ± 0.005 A; (5) its calculated crystal density is 4.59 g/cc; (6) it exists as a solid at 2300°C, although dissociation to BaO and ThO_2 commences at lower temperatures; and (7) it appears to be ferroelectric, with a Curie temperature of 260°C. $BaThO_3$ appears to hydrolyze readily in the presence of moisture and/or CO_2. It does not, therefore, appear to have the chemical stability required in a protective coating, and it is inadvisable to measure other coating parameters at this time. It may, however, serve as a superior thermionic emitter. (auth)

11574 (ARL-TR-60-309) A STUDY OF EMBRITTLEMENT OF HIGH STRENGTH STEELS BY THE HYDROGEN ISOTOPES. [Period covered]: July 1958 to July 1960. Gwendolyn B. Wood and Abner Brenner (National Bureau of Standards, Washington, D. C.). Dec. 1960. 54p. Contract AF33(616)-58-18.

A study was made to obtain a better understanding of the mechanism of hydrogen embrittlement through the study of the gas content of embrittled specimens. The specimens consisted of rings of 4130 steel, 2.54 cm in diameter, 0.9 cm long, and 0.08 cm wall thickness. They were electrolytically charged in several different solutions: 10% solution of sodium hydroxide, cyanide copper and cadmium plating baths, and chromic acid type of chromium plating bath. The measure of the embrittlement was taken as the decrease in either the crushing load or the deformation at failure, as compared to a control specimen. Deuterium embrittled 4130 steel, but to a much smaller extent than did hydrogen. On the other hand, specimens embrittled in solutions made with heavy water contained a larger volume of gas (deuterium) than specimens similarly treated for the same length of time in an ordinary water solution. (auth)

11575 (CEA-1542) INFLUENCE DES CONDITIONS DE LAMINAGE ET DE RECUIT SUR LA TEXTURE ET LES PROPRIETES MECANIQUES DU ZIRCONIUM. (Influence of Rolling and Annealing Conditions on Texture and Mechanical Properties of Zirconium). J. Orssaud (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). June 27, 1958. 72p.

Thesis submitted to the Univ. of Poitiers.

Rolling and annealing textures of zirconium samples at several rolling rates were studied by tracing diagrams of pole figures vs. the position in the sheet thickness with an automatic recorder. Tensile tests, hardness measurements, and micrographic examinations allowed a study of the evolution of the recrystallization and the variation of the mechanical properties after rolling and/or annealing. Annealing textures varied slightly with the annealing temperature. Annealing at 500°C gave several peculiarities.

This temperature seemed characteristic in the study of zirconium. (auth)

11576 (CEND-113) THE DEVELOPMENT AND TESTING OF HOMOGENEOUS CERAMIC FUELS. Quarterly Report, September 1, 1960–November 30, 1960. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Dec. 1960. 38p. Contract AT(30-1)-2379. (NYO-2993).

An investigation was made of the $CaO-UO_2-ZrO_2$ system to determine the effects of hydrogen sintering on the composition limits for single-phase fcc structures and the corrosion, physical, and thermal properties of select single-phase cubic structures. The specimens consisted of 10, 20, 28, and 35 mole % CaO-stabilized ZrO_2, containing 4 to 52 mole % UO_2, and were sintered at 1425, 1525, 1675, or 1750°C. Low-density single-phase structures were exhibited for 10 mole % CaO specimens at all sintering temperatures and 20 mole % CaO at 1425°C. Porous two-phase structures were found for 28 and 35 mole % CaO at 1425°C, in which the $CaZrO_3$ phase occurred in similar amounts for all UO_2 contents. A grain-boundary glassy structure was found in some specimens sintered above 1500°C, and was attributed to the reaction of volatile Al_2O_3 from the furnace tube and CaO in the specimen. The glassy-phase was found to decrease with increasing UO_2 content for the 20 mole % CaO specimens. The quantity and fluidity of the glassy phase are dependent on the CaO content, as indicated by complete absence at 10 mole %, to massive amounts at 28 and 35 mole % specimens. Oxygen in excess of stoichiometric UO_2 did not improve the sinterability of the system compositions in hydrogen. An experimental fixture utilizing a tungsten heater rod and hollow cylindrical specimens of the ceramic fuels was constructed. Argon-sintered specimens showed average weight gains of 1.5 to 8.7 mg/dm^2/day following 75 days exposure to 360°C degassed water at neutral pH. The weight gain rate decreased sharply with increasing exposure time. (B.O.G.)

11577 (CRRP-978) TEMPERATURE COEFFICIENT FOR A LATTICE OF 19-ELEMENT UO_2 CLUSTERS. R. E. Green, D. F. Allen, D. W. Hone, and A. Okazaki (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Oct. 1960. 53p. (AECL-1121).

Experiments were done in ZEEP to determine the temperature coefficient of buckling for a hexagonal lattice of 19-element UO_2 clusters spaced at 21.59 cm. The result was $(dB^2/dT) = -0.01133 \pm 0.00084\ m^{-2}/°C$ $20°C < T < 70°C$, in good agreement with calculations. The variation of the radial buckling with temperature accounts for ~30% of the total measured effect. This agrees with earlier calculations of the temperature dependence of the reflector savings in ZEEP, and resolves a long-standing discrepancy between calculations of (dB^2/dT) and experimental values which were based solely on the variation of critical height with temperature, i.e., the radial buckling was assumed constant. The value obtained for (dB^2/dT) was combined with calculations of the changes in L^2 and L_t^2 with temperature to yield a value for $(\Delta k/\Delta T)$, viz., $(\Delta k/\Delta T) = -9.24 \times 10^{-5}/°C$ $20°C < T < 70°C$. (auth)

11578 (DEG-Report-107) THE DETERMINATION OF HYDROGEN IN MAGNOX A12. R. Berry, J. A. J. Walker, and A. E. Clarke (United Kingdom Atomic Energy Authority. Industrial Group. H. Q. Risley, Lancs, England). May 12, 1960. 19p.

To provide analytical data for assessing the effect of hydrogen on the mechanical properties of Magnox A12, a reliable method of determining its hydrogen content is necessary. Three methods were investigated: vacuum extraction at 550°C, vacuum sublimation at 750°C, and vacuum fusion at 400°C, using a tin bath. Of these methods vacuum sublimation appears to be the most suitable for routine analysis. The surface conditions of both the samples and the apparatus can introduce significant errors in all three methods. For good results samples must be prepared by abrading and then stored in a moisture-free atmosphere. The preparation of suitable standards by the diffusion of hydrogen into Magnox A12 was unsuccessful. The standard deviation for the vacuum-sublimation method is 0.02 at the 0.10 ml/g level. (auth)

11579 (DMIC-145) DESIGN INFORMATION OF TITANIUM ALLOYS FOR AIRCRAFT AND MISSILES. W. P. Achbach and R. J. Favor (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 10, 1961. Contract AF33(616)-7747. 86p. (PB-151104).

Design strength properties and related characteristics of wrought titanium and its alloys used in missile and aircraft structures are given. The strength properties include tensile, compression, bearing, and shear. Effects of low and high temperatures are given where available. Information is given for pure titanium, Ti–Mn, Ti–Al–Mn, Ti–Al–V, Ti–Al–Mo–V, Ti–Al–Sn, and Ti–Al–Cr–Mo–Fe. (T.R.H.)

11580 (DMIC-Memo-81) DESIGN PROPERTIES AS AFFECTED BY CRYOGENIC TEMPERATURES. (Ti–6Al–4V, AISI 4340, AND 7079-T6 ALLOYS). W. P. Achbach and R. J. Favor (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 24, 1961. 18p. Contract AF33(616)-6410. (PB-161231)

Data on ultimate tensile strength, yield strength, modulus of elasticity, stress-strain relations, and toughness behavior are presented for annealed Ti–6 Al–4 V alloy, quenched and tempered AISI 4340, and solution-treated and aged 7079-T6 aluminum at cryogenic temperatures. (J.R.D.)

11581 (DMIC-Memo-84) THE EVOLUTION OF NICKEL-BASE PRECIPITATION-HARDENING SUPERALLOYS. J. G. Hoag (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 6, 1961. 13p. (PB-161234)

Each of the superalloys falls within one of three groups: nickel-base, cobalt-base, or iron–nickel–chromium-base. The nickel-base alloys are basically nickel–chromium alloys, which derive their high-temperature strength from both precipitation and solid solution hardening. Precipitation hardening is accomplished by the addition of aluminum and titanium, whereas solid-solution hardening is accomplished by the addition of one or more of the elements molybdenum, tungsten, or niobium. (W.L.H.)

11582 (HW-60346) VIBRATION-COMPACTED CERAMIC FUEL ELEMENTS (INVENTION REPORT). J. J. Hauth (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 9, 1959. 4p.

A method is described for compacting uranium dioxide and other ceramic or cermet nuclear fuel materials for ultimate use as reactor fuel elements. The vibration of ceramic fuel materials at the resonant frequency of the metal encasing material, using high rates of acceleration, produces uniformly compacted high-density fuel elements (auth)

11583 (IS-246) THE STRUCTURE OF U_2Zn_{17}. C. L. Vold and D. T. Peterson (Ames Lab., Iowa). Jan. 1961. 27p. Contract W-7405-eng-82.

The crystal structure of the intermetallic compound U_2Zn_{17} was determined. Two modifications, one having hexagonal and one having rhombohedral symmetry, were observed. The structures were similar and differed principally in the stacking of a basic structural layer. A stack-

ing fault in the hexagonal modification was found. Both structure determinations were refined by a least squares method which produced an R of 0.127 for the rhombohedral structure and an R of 0.126 for the hexagonal structure when the reflections influenced by the disorder were excluded. The hexagonal structure is related to Th_2Ni_{17} and the rhombohedral structure is related to Th_2Zn_{17}. (auth)

11584 (NAA-SR-4528) RESULTS OF HIGH-TEMPERATURE STRAIN-FATIGUE TESTS ON REACTOR-GRADE ALUMINUM-BASE MATERIALS. W. F. Anderson and W. Wahl (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 30, 1961. 42p. Contract AT(11-1)-GEN-8.

Strain-fatigue tests were conducted on two reactor-grade aluminum-base alloys and a sintered aluminum product at 80 to 900°F. The materials are used in reactor components, and one of the aluminum alloys has a potential for use in experimental models. Results of the tests indicate that strain-fatigue behavior at room temperature for the materials was similar to that of other ductile materials. The aluminum-alloy specimens at 600°F yielded results of limited value owing to the instability of the specimens. At 900°F the sintered aluminum product exhibited a significant loss of ductility with a cyclic life 16% of that at 600°F. (auth)

11585 (NASA-TR-R-91) THE EFFECT OF REPEATED STRESSING ON THE BEHAVIOR OF LITHIUM FLUORIDE CRYSTALS. Arthur J. McEvily, Jr. (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.) and E. S. Machlin (Columbia Univ., New York). 1961. 32p.

Results of reversed-bend tests on LiF single crystals at 2 cpm are similar to those obtained at 1800 cpm, indicating that speed effects are relatively unimportant. Reversed-torsion tests yield additional evidence that vacancy formation is not a primary cause of fatigue failure. Since LiF does not readily cross slip, the absence of fatigue failures lends further support to the theory that cross slip is necessary in order to obtain usual fatigue behavior. The results demonstrate that dislocation pileups do not lead to failure in LiF, and that plastic deformation in the course of reversed cycling will relax an initially applied mean load. Etch-pit studies yield visual evidence of the growth of slip-bands during cycling. (auth)

11586 (NMI-7205) DEVELOPMENT OF ECONOMICAL ETCHING PROCEDURE FOR ZIRCALOY. Summary Report. R. G. Jenkins (Nuclear Metals, Inc., Concord, Mass.). Oct. 18, 1960. Contract AT(30-1)-1565, Sponsor Agreement No. S-31. 30p.

The bright etching procedure originally used for Zircaloy-clad fuel tubes for the du Pont Power Reactor Program was revised. Commercial grades of nitric and hydrofluoric acids, replenished etch baths, and all-water rinses may now be used to prepare the Zircaloy cladding for exposure to corrosion by high-temperature water or steam. Wetting agents do not noticeably affect etching rates in the normal range of temperatures encountered with the power tube etching solution. (auth)

11587 (NP-9790) INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS. Summary Report No. 4, November 1, 1959 to October 31, 1960. C. R. Mason, C. A. Murphy, A. T. Sales, and J. D. Walton (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 185p. Contract NOrd-15701.

A technique for producing wax molds without machining was developed to be used in casting alundum heater plates. The heater plates fabricated by this technique for the thermal conductivity apparatus checked out very well. Measured thermal conductivity of unicellular, foamed fused silica increased rapidly with increased temperature. The thermal conductivity and thermal diffusivity of slip-cast fused silica were determined by backside temperature measurements on samples exposed to the oxyhydrogen rocket motor. The F-40 arc-plasma unit was investigated to determine the influence of gas flow rate on arc stability and unit efficiency. Machined water- and air-cooled brass patterns, slip-cast fused silica patterns, and machined graphite patterns were used in an effort to reduce the standoff distance of the plasma gun when forming thin arc-sprayed shapes. The average bulk densities per cent theoretical densities and indicated tensile strength for ZrO_2, Cr_3C_2, W, and Al_2O_3 are listed. Six tensile test specimens were obtained by arc-spraying molybdenum disilicide onto a graphite pattern. Samples of molybdenum sheet, stainless steel, silicon carbide foam, and silicon carbide rod were arc sprayed with 90% zirconium diboride–10% molybdenum disilicide powder. Efforts at spraying fused silica produced a thin coating on a fired fused silica plate that resisted color change after being subjected to an oxidizing atmosphere for 8 hr at 1600°F. An x-ray analysis was made on a thermet containing 65% beryllium–chromic oxide thermite and 35% beryllia to determine the various components or compounds found in an ignited sample. Investigations were made to determine the properties and effects produced in beryllium–chromic oxide thermite when beryllia and chromium are used as a combined throttling material. Studies were begun to develop a slip-casting technique to be used with beryllium–chromic oxide thermets. (W.L.H.)

11588 (NP-9490(Vol.I)) REFRACTORY METALS STRUCTURAL DEVELOPMENT PROGRAM. VOLUME I. Quarterly Progress Report No. 3, December 1, 1959–February 29, 1960. Report No. 7380. R. D. Brunson (McDonnell Aircraft Corp., St. Louis). Mar. 15, 1960. Contract AF33(616)-6578. 102p.

The principal achievements include preliminary design completed, final design approach chosen, WADD review of final component layout, completion of majority of test assembly fabrication, sequence determination of test assembly coating application, testing and analysis of representative stainless-steel structures, final component alloy selection, final component experimental fastener fabrication initiated, final component loads report released, experimental sheet metal explosive forming begun, and final component internal load analysis started. (auth)

11589 (NP-9490(Vol.II)) REFRACTORY ALLOYS FOR USE AS STRUCTURAL MATERIALS IN RE-ENTRY OR BOOST GLIDE VEHICLES. VOLUME II. Quarterly Report No. 3, December 1, 1959 to February 29, 1960. Report No. 7380. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Mar. 1, 1960. Contract AF33(616)-6578. 142p. For McDonnell Aircraft Corp.

Additional niobium alloys were uncovered with the release of the first interim report of the AMC niobium sheet rolling program. Three alloys Nb7, Nb16, and D41 look sufficiently promising to warrant further work and evaluation. The majority of the test data on the four candidate alloys was obtained and is reported. Upon evaluation of the data, one alloy, F-48, was selected as the major material of construction for the final test component (fin-rudder assembly). All material for the test box program was received (½Zr–Mo, FS-82) as well as additional material ordered for the program (Zr–Nb, ½Ti–Mo). Material in-

ventories and quality control tests are reported. Sheet 0.020 and 0.040 × 10 in. of F-48 alloy was also received for purposes of more detailed design data, welding, and coating studies. Orders for 1000 lb of F-48 billet were placed to provide sheet for the final structure. Continued studies in process development of F-48, resistance and fusion welding of F-48 and FS-82, and coating of F-48, FS-82, and $^1/_2$Zr–Mo are well underway. (auth)

11590 (NP-9812) SOME ASPECTS OF THE ORIGIN OF DISLOCATIONS IN METAL CRYSTALS. Stephen Howe and Charles Elbaum (Brown Univ., Providence. Metals Research Lab.). Feb. 1, 1961. 79p. Contract Nonr-562(27).

Single crystals of 99.999% pure and zone-refined aluminum were grown by the Czochralski method. The axes of most of the crystals were parallel to a <110> direction. The carrot-shaped crystals were about 4 cm long, tapering from a diameter of about 3 mm at the top to about 0.1 mm at the bottom. X-ray-diffraction micrographs were taken of the crystals by means of Lang's technique, which is capable of revealing the dislocation structure in the interior of a crystal. It was found that the density of dislocations present in an as-grown crystal increases with both increasing diameter and rate of growth. The mechanism of formation of the majority of these initial dislocations is thought to be the collapse of vacancy disks that are nucleated as the crystal grows, when a sufficient supersaturation of vacancies is reached in the crystal. Theoretical calculations of the supersaturation of vacancies that occur in a crystal were made by considering the diffusion of vacancies in a crystal cooled from the melting temperature. The range of diameters below which the vacancy supersaturation is too small to nucleate a dislocation is of the same order of magnitude as the diameters of crystals found which contain no detectable dislocations. In some cases, dislocations were found only on the surface of the crystals; these dislocations could be removed by careful electropolishing, thus producing crystals free of detectable dislocations. The production of dislocations near the surface is attributed to shear stresses during growth from drag of the rotating crystal against the stationary melt. (auth)

11591 (NP-9822) SELECTION OF STEELS FOR THE AVOIDANCE OF BRITTLE FAILURE. K. Winterton (Canada. Dept. of Mines and Technical Surveys, Mines Branch). July 1960. 49p.

Available as Can. Dept. Mines Tech. Surveys, Mines Branch Inform. Cir. IC-120. $0.25.

The factors that have an adverse effect on the ductile-brittle transition include cold-work, strain-aging, quench-aging, large-grain size, and increasing contents of carbon, phosphorus, nitrogen, and silicon (over 0.4%). The factors that have a beneficial effect include fine-grain size, deoxidation, heat treatment, and increasing contents of manganese and nickel. An understanding of the factors involved has led to changes in the type of steel selected for ship and land applications for which brittle failure might be apprehended. The Bessemer process has virtually disappeared, to be replaced by the open-hearth process, the L. D. (Linz-Donawitz) process, and others. Semi-killed steel is preferred to rimming steel. There is a tendency to maintain the required strength in steels by increasing the manganese content to permit a reduced carbon content. For best properties fully deoxidized steels may be used, often in the normalized or quenched-and-tempered condition. As a last resort alloy steels may be used, usually in the fully heat-treated condition. Proposals are discussed for the development of a series of Canadian steels with progressively increasing resistance to brittle failure. A similar series of British steels is already available. (auth)

11592 (NP-9843) RESEARCH IN PHYSICAL AND CHEMICAL PRINCIPLES AFFECTING HIGH TEMPERATURE MATERIALS FOR ROCKET NOZZLES. Semiannual Progress Report for period July 1, 1960-December 31, 1960. Robert Lowrie (Union Carbide Nuclear Co. Research Center, Tuxedo, N. Y. and Union Carbide Corp. Parma Research Lab., Ohio). Dec. 31, 1960. Contract DA-30-069-ORD-2782. 90p.

Mass spectroscopy was used to measure the heat of sublimation of palladium ($\Delta H_{298} = 91.6 \pm 1.4$ kcal/mole), to study the vaporization of TiB_2 and AlN, and to measure the evaporation coefficients of single-crystal faces of silver and silicon. A new small-orifice Knudsen cell was developed to allow higher vapor pressures to be used in the cell, and it has been used successfully with copper. Equipment was assembled for conducting vapor-emission spectroscopy up to 2800°C, and bands were observed which are tentatively assigned to LaC_2. The reaction of carbon with hydrogen was conducted in two systems at 1730 to 2340°C. In addition to methane, acetylene, ethylene, and ethane were identified in the products. The reaction of nitrogen, activated by a microwave discharge, with carbon at 1300 to 1500°C resulted mainly in the production of cyanogen, and a solid which may be polycyanogen. A new technique, the Rectangular Bar Method was developed for measuring thermal conductivity and specific heat above 700°C. Data are reported on these quantities and the electrical resistivity of HfC up to 2500°C. The equipment for conducting tensile creep tests of high temperatures is still under construction but data were obtained on the creep of single-crystal specimens of MgO tested in bending at 1500 to 1700°C. Electron microscope observations were also made of dislocations, cracks, and precipitates in MgO. A pulse-echo technique, modified to permit measurements at elevated temperatures, was developed for measuring elastic properties at high temperatures. The method has given excellent agreement with literature values for fused silica and synthetic sapphire at room temperatue, and data were readily obtained on an aluminum alloy up to its solidus temperature. Precision lattice parameters and rms atomic displacements were measured for TiN and ZrN at room temperature, and a furnace and associated equipment for measurements at high temperatures is nearing completion. At room temperature the atomic displacements were the same for both atoms in a compound, indicating that acoustic waves primarily caused the displacements. Facilities were assembled for pressing, extruding, sintering (in hydrogen or vacuum), and hot-pressing specimens of the refractory compounds. Efforts to produce powders of greater putity were centered on the carbides and nitrides of the Group IV metals with encouraging results. (For preceding period see AD-239305.) (auth)

11593 (NRL-5520) ELEVATED TEMPERATURE DIFFUSION IN THE SYSTEMS Nb–Pt, Nb–Se, Nb–Zn, Nb–Co, Ni–Ta, AND Fe–Mo. R. E. Seebold and L. S. Birks (Naval Research Lab., Washington, D. C.). Sept. 19, 1960. 13p.

The electron probe microanalyzer was used to determine the composition and extent of phases occurring in bimetal diffusion couples at 1100°C. A total of eighteen phases was determined in six binary systems: Nb–Pt, Nb–Se, Nb–Zn, Nb–Co, Ni–Ta, and Fe–Mo. In all cases the phases are stoichiometric and expressible in small whole numbers. The Nb–Se and Nb–Zn systems are somewhat alike in their phase formations in that Nb–Se exhibits Nb–Se, Nb_2Se_3, and Nb–Se_2 while Nb–Zn produces Nb–Zn, Nb_2Zn_3, $NbZn_2$, and $NbZn_3$. Diffusion between niobium and platinum to form Nb_3Pt, NbPt, $NbPt_3$, and $NbPt_3$ would seem to preclude prolonged use of platinum thermocouples in contact

with niobium at 1100°C. The only phases produced in the Nb–Co system are previously unreported in the literature and are Nb_3Co_2 and $NbCo_4$. This system also exhibited an extended region containing about 5 wt.% niobium in cobalt in agreement with the solubility limit shown in existing phase diagrams. Na–Ta diffusion produced zones which showed strong cracking and grain formation. The phases $TaNi_3$, $TaNi_2$, TaNi, and Ta_3Ni_2 comprised the zones, with pure tantalum precipitating in the $TaNi_2$ phase on cooling from 1100°C. Fe–Mo produced only one phase: Mo_2Fe_3. (auth)

11594 (PA-TM-ME-5-59) INVESTIGATION AND EVALUATION OF AVAILABLE HYPERSONIC PROBE MATERIALS AND OXIDATION-RESISTANT COATINGS FOR POSSIBLE USE AT 4000°F FOR 60 SECONDS. Domenic J. Molella (Picatinny Arsenal. Feltman Research and Engineering Labs., Dover, N. J.). Dec. 1959. 44p. Project No. TN2-8109. (AD-240344)

Various refractory, ceramic, and cermet materials were evaluated for use on a hypersonic probe at 4000°F for 60 sec. The materials were evaluated on the probe itself in a water-stabilized plasma-jet after exposure to varying heat inputs up to 500 BTU's per sq ft-sec for 60 sec. Disregarding availability and cost, it is concluded that the most ideal hypersonic material would be rhenium. (C.J.G.)

11595 (R59SD423) THE HEAT PROTECTION POTENTIAL OF SEVERAL ABLATION MATERIALS FOR SATELLITE AND BALLISTIC RE-ENTRY INTO THE EARTH'S ATMOSPHERE. N. S. Diaconis, J. B. Fanucci, and G. W. Sutton (General Electric Co. Missile and Space Vehicle Dept., Philadelphia). Sept. 11, 1959. Contract AF24(647)-269. 65p.

An evaluation of the relative performance advantage of various ablation materials for the heat protection to a nonlifting vehicle during hypersonic reentry into the earth's atmosphere was made based on theoretical ablation models substantiated by experiment. Calculations were also made of the heat penetration within the material. Typical ablation materials from three categories were investigated, both theoretically and experimentally in air arc facilities at a hypersonic stagnation point. Stagnation point ablation data for an attractive material in each category were obtained for various local heating rates, stagnation pressures, and stagnation enthalpies. Effective heats of ablation were determined experimentally and compared with the theoretical calculations. (auth)

11596 (RAD-SR-16-60-28) A STUDY OF THE MOLECULAR SPECIES EVAPORATING FROM CONDENSED PHASES AT HIGH TEMPERATURES AND THE MEASUREMENT OF CERTAIN PHYSICAL PROPERTIES OF REFRACTORIES AT HIGH TEMPERATURES. Quarterly Technical Summary Report No. 2. A. A. Hasapis, M. B. Panish, and C. Rosen (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). May 18, 1960. 41p. Contract AF33(616)-6840. (AD-236866)

Simple effusion studies of the vaporization of iridium and osmium were undertaken by the Knudsen effusion technique. The rate of effusion was determined by condensing the molecular beam on a target. The vaporization of iridium was studied from 2100 to 2600°K. In this range the tentative value for the heat of vaporization is 155 ± 5 kcal/mole. It was noted that some interaction between the iridium, the thoria liner, and the tungsten outer liner of the effusion cell may have occurred. No data were obtained for the vaporization of osmium because of extensive interaction between the thoria liner and the tungsten outer liner of the effusion cell. Mass spectrometric studies of the vaporization of thoria were continued. Interactions between thoria and tungsten at elevated temperatures were noted. Tentative data on the vaporization of thoria to ThO and ThO_2 were obtained. The continuously monitored effusion apparatus, the null-point effusion apparatus, the oscillating cup viscometer, and the sessile drop equipment were calibrated. The viscosity of silica has been determined at temperatures up to 2560°C where $\eta = 10^{4.44}$. (auth)

11597 (RAD-SR-16-61-1) THE VAPORIZATION AND PHYSICAL PROPERTIES OF CERTAIN REFRACTORIES. Quarterly Technical Summary Report No. 4. A. A. Hasapis, A. J. Melveger, M. B. Panish, L. Reif, and C. L. Rosen (Avco Corp. Research and Advanced Development Div., Wilmington, Mass). Jan. 10, 1961. 22p. Contract AF33 (616)-6840.

Vaporization studies on various refractories are described. Evidence of high-temperature reactions between iridium and carbon is presented. Thorium dioxide is shown to vaporize primarily as $ThO_{2(g)}$ with small quantities of ThO present, while hafnia (HfO_2) vaporizes to yield HfO + O. The species vaporizing from Pr_2O_3, Nd_2O_3, Sm_2O_3 and Gd_2O_3 were studied, and the heat, free energy, and entropy of formation were determined for $MoSi_2$, Mo_5Si_3, and Mo_3Si. The viscosities of silica with 1% vanadia were determined; the surface tensions of silica with 1% magnesia and with 1% alumina were also determined. (J.R.D.)

11598 (RAD-SR-18-60-120) FIRST ANNUAL PROGRESS REPORT — EXPLORATORY RESEARCH ON THE VAPORIZATION OF SOLIDS. Charles H. Leigh (Avco Mfg. Corp. Research and Advanced Development Div., Wilmington, Mass.). Dec. 31, 1960. 31p. Contract Nonr-3051(00) Task No. NR052-416. OTS.

Exploratory research is presented on the use of the plasma generator for an investigation of the effects of very high temperatures on solids. It is intended to study the processes of vaporization of simple refractory compounds and to determine the pressure and composition of the gaseous phase. A time-of-flight mass spectrometer was constructed for the specific problem with which this contract is concerned. This spectrometer was designed to permit the attachment of a high-temperature molecular beam probe directly below the ionization region. Studies were made on the design and construction of a high-temperature molecular beam probe. In the course of these studies, two high-temperature probes were designed and built. The second probe is a completely new design based upon the experience gained with the first probe design. Initial tests made with the second probe have shown that the design appears to be promising. A description of the experimental arrangement is given, with details of existing equipment. In addition to the construction of the mass spectrometer system and the two probes, a small plasma generator has been constructed. This plasma generator operates with an inert-gas stabilization, such as argon, and at a power level of approximately 6 kw. This generator is capable of attaining temperatures in excess of 3600°C. (auth)

11599 (TID-6919) PROGRESS REPORT ON WORK UNDERTAKEN ON PROJECT NO. 1 BETWEEN THE UNIVERSITY OF KANSAS AND THE ATOMIC ENERGY COMMISSION. Oct. 10, 1960. 9p. Contract AT(11-1)-83.

Work on the vaporization and phase studies of refractory substances is reported. Experimental work was finished on the following binary systems: Mo–O, W–O, U–S, Si–B, and Zr–B. Some research was performed and is continuing on the binary systems Ti–O, V–O, Ta–O, and rare earth–B. (W.L.H.)

11600 (USNRDL-TR-483) SOLAR ABSORPTANCE AND EMITTANCE OF REAL SURFACES AT HIGH TEMPERATURES. PART I. POLISHED METALS. C. P. Butler (Naval Radiological Defense Lab., San Francisco). Dec. 2, 1960. 23p.

A carbon arc-image furnace with radiation that simulates the sun was used to heat a specimen enclosed in a black-walled evacuated chamber. Solar absorptance and total hemispherical emittance values were obtained for six polished metals from 200 to 800°C. Optical instability due to thermal etching was demonstrated at the high temperatures. Thermal conversion efficiencies were calculated for each metal as a function of temperature. Commercially pure specimens of Ag, Au, Fe, Ni, Ta, and Mo were measured. (auth)

11601 (WADC-TR-57-374(Pt.V)) PHYSICAL PROPERTIES OF HIGH TEMPERATURE MATERIALS. PART V. THERMAL DIFFUSIVITY OF MAGNESIA-STABILIZED ZIRCONIUM OXIDE AT HIGH TEMPERATURES. Howard W. Flieger, Jr., Friedrich P. Knudsen, and Defoe C. Ginnigs (National Bureau of Standards, Washington, D. C.). June 15, 1960. Contract AF33(616)-56-21. 18p.

As a part of a program developing standards of thermal conductivity and thermal diffusivity of refractory materials at high temperatures, thermal diffusivity measurements were made on dense polycrystalline zirconium oxide which had been stabilized with magnesium oxide. The results indicate that the stabilization of the zirconium oxide was inadequate, giving progressively increasing values of thermal diffusivity after cycling to temperatures of about 1200°C. Thermal-expansion and x-ray measurements indicated that the increase in thermal diffusivity values corresponded to a change from cubic to monoclinic crystalline form. (auth)

11602 (WADD-TR-60-56(Pt.III)) A COMPENDIUM OF THE PROPERTIES OF MATERIALS AT LOW TEMPERATURE (PHASE 1). PART III. BIBLIOGRAPHY OF REFERENCES (CROSS-INDEXED). Victor J. Johnson, ed. (National Bureau of Standards. Cryogenic Engineering Lab., Boulder, Colo.). October 1960. 171p. Contract AF33(616)58-4. Project No. 7360.

This first phase of the Compendium covers 10 properties of 10 fluids (Part I), three properties of solids (Part II), and an extensive bibliography of references (Part III). Density, expansivity, thermal conductivity, specific heat and enthalpy, transition heats, phase equilibria, dielectric constants, adsorption, surface tension and viscosity for the solid, liquid and gas phases of helium, hydrogen, neon, nitrogen, oxygen, air, carbon monoxide, fluorine, argon, and methane are given wherever adequate data could be collected. Thermal expansion, thermal conductivity, and specific heat and enthalpy are given for a number of solids of interest in cryogenic engineering. Data sheets, primarily in graphic form, are presented from "best values" of data collected. The source of the material used and other references and tables of selected values with appropriate comments are furnished with each data sheet to document the data presented. Conversion tables and other helpful information are also included. (auth)

11603 (WADD-TR-60-74(Pt.I)) THE METALLURGY OF YTTRIUM AND THE RARE EARTH METALS. PART I. PHASE RELATIONSHIPS. Period covered: October 1958 to October 1959. Bernard Love (Research Chemicals, Inc., Burbank, Calif.). Jan. 20, 1960. 246p. Contract AF33 (616)-5905. (AD-242706).

Partial constitutional diagrams were established for sixteen binary systems containing rare-earth metals. Erbium and yttrium form simple binary eutectic systems with titanium. No compounds are present. The transition temperature of titanium is not significantly affected. Copper, tin, and cobalt form intermetallic compounds with erbium and yttrium. The melting points of the rare earths are rapidly lowered, eutectics forming with the respective compounds. Vanadium forms extensive (and chromium forms limited) liquid immiscibility regions with erbium and yttrium. Eutectics are formed at the rare-earth end of the systems. Terminal solubilities are low in all the above systems. The system erbium–zirconium is characterized by appreciable solubility of zirconium in erbium and extensive solubility of erbium in both alpha and beta zirconium. There are no intermetallic compounds. The alpha erbium and beta zirconium solid solutions enter into a simple eutectic reaction. A high temperature peritectic reaction involving beta erbium is suggested. The system yttrium–zirconium is similar in all major respects except that the solubility limits at both ends of the system are somewhat lower. Preliminary investigation of the gadolinium–zirconium system indicated similarity in all major respects. Beryllium and ytterbium form an intermetallic compound. The terminal solubility of ytterbium in beryllium is low. No eutectic is observed at the beryllium end of the system. The results obtained suggest zirconium as a promising alloying element. Evidence was found for the purification of vanadium and beryllium when these metals were melted together with rare earths. (auth)

11604 (WADD-TR-60-95) FURTHER STUDIES ON ACTIVE-EUTECTOID ALLOYS OF TITANIUM. R. F. Bunshah, D. Osterberg, E. Ence, and H. Margolin (New York Univ., New York. Coll. of Engineering). May 1960. 80p. Contract AF33(616)-5655. (AD-240933)

Work on active eutectoid titanium-copper alloys in which the decomposition of the beta phase to alpha plus compound occurs rapidly is reported. The effect of stepwise additions of aluminum and/or zirconium to binary Ti–5Cu, Ti–6Cu, Ti–6Ni, Ti–2Ni–2Cu, and Ti–4Ni–2Cu alloys on the tensile strength at room and elevated temperatures, creep-rupture properties, and thermal stability under stress were studied. Several alloys exhibited outstanding short time tensile strengths up to 1200°F which were much superior to the best competition. The creep-rupture properties were correspondingly good. These alloys that exhibited highest strengths also showed instability. Stability could be restored partially by some sacrifices in strength. (auth)

11605 (WADD-TR-60-310) THE EFFECT OF SEVERAL GEOMETRICAL VARIABLES ON THE NOTCH TENSILE STRENGTH OF 4340 STEEL SHEET HEAT TREATED TO THREE STRENGTH LEVELS. Volker Weiss, John Sessler, Paul Packman, and George Sachs (Syracuse Univ., N. Y. Research Inst.). June 1960. Contract AF33(616)-6523. 41p.

A systematic study was conducted to evaluate the effects of initial stress distribution and strength level on the notch tensile behavior of a typical high-strength-steel sheet alloy (SAE 4340) in the presence of stress concentrations. The initial stress distribution, characterized by the stress concentration factor (K) and the stress gradient at the root of a notch, was determined analytically from the notch geometry according to elastic theory. As part of the study, K was kept constant and the stress gradient allowed to vary for different notch depths and section widths. The 4340 steel sheet alloy was tested in three different heat treat conditions ranging from ductile (F_{tu} = 150 ksi) to moderately notch brittle (F_{tu} = 260 ksi). For the material conditions investigated, it was found that the effect of stress gradient on notch strength was fundamentally identical with

that of section width. Increasing the section width (or decreasing the stress gradient) resulted in a decrease in notch strength when all other factors were held constant. However, the effect was small when compared to the section size effect observed previously for notched cylindrical bars. In addition, results of tests on an extremely brittle titanium sheet alloy indicated that the stress gradient is the predominant factor that influences notch strength. For a truly brittle material, which exhibits no plastic deformation prior to fracture, it appears that the stress concentration factor, the depth of a notch and the specimen width are significant only insofar as they contribute to the magnitude of the stress gradient and the maximum stress at the notch root. (auth)

11606 (WADD-TR-60-338) INFLUENCE OF ENVIRONMENT ON CERAMIC PROPERTIES. George R. Pulliam and Bruce G. Leonard (Douglas Aircraft Co., Inc., Long Beach, Calif.). July 1960. Contract AF33(616)-5875. 31p.

Environmental and nonstoichiometric effects on ZrO_2, AgCl, and MgO single crystals were studied. Evidences of low temperature plastic strain found for oxygen-deficient ZrO_2 were nonlinear stress-deflection curves at room temperature, appearance of slip lines on large grains after stress, and creep at 350°C. The creep of polycrystalline AgCl was found to be highly sensitive to electromagnetic radiation. When an AgCl specimen in creep was illuminated with 440μ light, the creep rate was reduced; and light of 700μ caused the previously reduced creep rate to be increased. MgO single crystals colored brown by ultraviolet irradiation were found to have an absorption peak at 4.3 ev associated with oxygen. Ultraviolet irradiation increased the height of this peak so that it tailed off in the visible region imparting the brown color to the crystals. Vacuum treatment of such specimens to 1300°C removed the peak and prevented further coloration by ultraviolet illumination. (auth)

11607 (WADD-TR-60-343) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. Covers work done from May 1959 to May 1960. E. M. Passmore, J. E. Boyd, L. P. Neal, C. A. Anderson, and B. S. Lement (Manufacturing Labs., Inc., Cambridge, Mass.). August 1960. Contract AF33(616)-6354, Project No. 9(8-7312).

Twenty-three base-barrier metal combinations were screened by annealing diffusion couples at 1700 ± 15°C. Measurements indicating the extent of interdiffusion between barrier and base metals were made by metallographic examination, microhardness tests, and electron microbeam analysis. From these measurements, it is concluded that hafnium and iridium are the most promising barriers for tungsten at 1700°C, with vanadium as a third choice. Iridium appears to be the best choice for tantalum and molybdenum. No recommendations could be made for niobium base metal, primarily because of melting at the screening temperature. A comparison of interdiffusion behavior with base-barrier phase relations indicates no correlation with either solid solubility or the presence of intermediate phases. The melting points of both barrier and base appear to be the most important factors affecting the extent of interdiffusion. (auth)

11608 (WADD-TR-60-377) STABILITY OF CERAMIC MATERIALS AT TEMPERATURES TO 2000°C. John Berkowitz (Little (Arthur D.) Inc., Cambridge, Mass.). Sept. 1960. 67p. Contract AF33(616)-6154, Project No. 7350.

A study was made of the oxidation resistance of a number of commercial samples of $MoSi_2$ and WSi_2 at 1600 to 1700°C. A thermal-conductivity technique was developed to continuously measure oxygen pickup by the samples. From the thermal-conductivity measurement and the net weight change of the samples, an estimate was made of the formation rates of volatile and nonvolatile oxides. On the basis of x ray analysis, oxidation products are believed to be volatile XO_3 (vapor) and nonvolatile glass of the form SiO_2nXO_m, where X = Mo or W and n and m are not known. Tests were conducted at a total pressure of 1 atm in a helium stream containing about 10 mm of oxygen and flowing at 119 cm^3/min. The oxidation of WSi_2 was also studied in a helium stream containing 5 mm of water vapor. The principal solid product in this case was metallic tungsten. (auth)

11609 (WADD-TR-60-393) EVALUATION OF BRAZED HONEYCOMB STRUCTURES. Robert C. McMaster, Anthony T. D'Annessa, and Henry W. Babel (Ohio State Univ., Columbus). Sept. 1960. Contract AF33(616)-6364. 320p.

A study was made of commercially available nondestructive test methods for the evaluation of brazed honeycomb structures. Surface-layer discontinuities in bonding were detected reliably by x-ray, ultrasonic, and thermal gradient tests. Internal discontinuities were detectable only with penetrating radiation tests. X-ray test methods evaluated included film radiography, xeroradiography, direct fluoroscopy, television fluoroscopic systems, electrostatic and photoconductive-screen x-ray image amplifiers. Ultrasonic test methods studied included immersion ultrasonic tests with focused transducers, contact ultrasonic tests with resonance transducers, and contact ultrasonic tests with pulse-reflection systems. Thermal test methods evaluated included thermal-flash proof tests, tests with heat-repelled fluid coatings, tests with thermographic phosphor coatings, tests with color-changing paint coatings, and tests with remote infrared sensing systems. Results of destructive tests on honeycomb parts confirm indications of bond conditions of x-ray, ultrasonic, and thermal tests. Further research and development are recommended for zeroradiography, photoconductive-screen television systems, and thermal-gradient tests. (auth)

11610 (WADD-TR-60-443) PARTITIONING AND MICROSTRUCTURE OF INTERSTITIAL ALLOYING IN TITANIUM. Irving B. Cadoff and Joseph Winter (New York Univ., New York). July 7, 1960. 41p. Contract AF33(616)-5506.

The partitioning or segregation of excess interstitial solutes at the grain boundaries in alpha-phase and beta-phase titanium alloys was investigated. Internal friction spectra of dilute alloys of titanium with oxygen, nitrogen, and carbon were obtained. From these spectra the activation energy for grain-boundary stress relaxation, the net interaction energy of a solute atom with a grain boundary, and the excess solute concentration were calculated. As in previous investigations of this type, the partitioning of excess solute was found to obey a relation of the form $C_s = C_g \exp V_s/kT$ The interaction energies were found to lie in the range 0.15 to 0.40 ev for binary interstitial alloys. Tensile measurements indicated that the increase of excess solute at grain boundaries and dislocations brought about by either increasing the bulk concentration or decreasing the equilibrium annealing temperature resulted in an increase in yield strength. The effect of excess solute on yield stress was found to be parallel to its effect on the internal friction spectra. (auth)

11611 (WVTRR-6010) PRACTICAL EVALUATION OF THE STANDARD STRESS-STRAIN CURVES AND RELATED PROPERTIES. R. H. Harrington (Watervliet Arsenal, N. Y.). July 1960. 32p. (PB-161896)

Yield strength can not be relied upon per se for the most economical and even safe use of new high-strength steels, other new alloys, and new esoteric treatments. The various properties associated with the standard stress-strain curve are evaluated and related to the behavior of alloys under stress. Several other properties, directly related to the stress-strain curve, are preferable to the 0.10 or 0.20% offset yield strengths for present applications and future developments. Only major experienced opinion can choose the property to best serve the purpose for this new era. In any case, it is the ability of an alloy to deform elastically without measurable plastic deformation that determines its most efficient and truly safe use in the vast majority of applications. (auth)

11612 (AEC-tr-4441) EMPLOYING THE PARAMETERS OF EMPIRICAL FORMULAS THAT RELATE HARDNESS TO TEMPERATURE, DURATION OF LOAD, AND PRESSURE TO DETERMINE THE LIMITS OF SOLUBILITY IN THE SOLID STATE. V. P. Shishokin and A. E. Nikerov. Translated from Izvest. Vysshikh Ucheb. Zavedenii, Chernaya Met., No. 3, 91-5(1960). 6p.

A study was made of the influence of composition on the parameters of empirical equations for solid solutions of silver in cadmium, mercury in tin, and sodium, cadmium, and antimony in lead. Tests indicated that under certain conditions hardness is related to the diameter of the indentation by an exponential law. Relations are developed to show the time and temperature dependences. The parameters that relate hardness to the load, time duration of application, and the temperature are governed by the experimental conditions, as well as the composition. The computed values of the parameters are shown graphically as a function of composition. (B.O.G.)

11613 (AEC-tr-4274) PHENOMENOLOGICAL ASPECT OF SOME PHYSICAL PROPERTIES OF PLUTONIUM AND PLUTONIUM ALUMINUM SOLID SOLUTIONS. Y. A. Rocher and J. Friedel. Translation. [1960]. 14p.

The low temperature anomalies of electrical resistivity and thermoelectric power observed on plutonium and δ plutonium-aluminum solid solutions are interpreted in terms of an order-disorder change. A study of short-range order above the critical temperature indicated a decrease in the number of conduction electrons from 1 to 0.5 per atom forms pure δ plutonium to the 10 at.% aluminum δ solid solution. The possible nature of the low temperature order is discussed. The anomalous expansion observed in δ plutonium and δ plutonium-aluminum solid solutions is related to a thermally activated process. The corresponding activation energy increased linearly from 0.17 to 0.27 ev as the aluminum atomic concentration goes from 0 to 5%. (auth)

11614 (AEC-tr-4391) NEW COMPOUND IN THE RHENIUM-ZIRCONIUM SYSTEM AND ITS CRYSTAL STRUCTURE. P. I. Kripyakevich, M. A. Tylkina, and E. (Ye.) M. Savitskii (Savitskiy). Translated by J. Woroncow from Izvest. Vysshikh Ucheb. Zavedenii, Chernaya Met., No. 1, 12-15(1960). 7p. (XDC-60-11-131).

An x-ray structural investigation of the Zr–Re alloy system enriched with rhenium is described. Preliminary investigation of the alloy with 88.96 wt.% rhenium revealed that in addition to $ZrRe_2$ it contains another phase which differs from rhenium and it is represented on an x-ray pattern by several lines identifying a cubic structure. (auth)

11615 (CEA-tr-R-962) DIFFUSION DE L'OXYGÈNE ET DE L'HYDROGÈNE DANS L'ACIER AU COURS DE LA CÉMENTATION. (Diffusion of Oxygen and Hydrogen in Steel During Case Hardening). O. K. Kotov. Translated into French from Metalloved. i Obrabotka Metal. No. 8, 13-45(1959). 7p.

An experimental study was made of the possibility of adsorption of oxygen and hydrogen atoms by steel during cementation. During cementation by fusel oil and "cement," a solid carburation agent, a saturation of the steel by H_2 and O_2, as well as carbon, resulted. During cementation by ethanolamine, the surface layer was also saturated by N_2. (T.R.H.)

11616 (CEA-tr-X-220) ETUDE DES ALLIAGES SPECIAUX DE MAGNESIUM OBTENUS PAR COULEE. II. EFFET DE L'ADDITION DE ZIRCONIUM SUR LES PROPRIETES MECHANIQUES DU MAGNESIUM ET DE SES ALLIAGES. (Study of Special Magnesium Alloys Obtained by Casting. II. Effect of Addition of Zirconium on Mechanical Properties of Magnesium and Its Alloys.) M. Tsukuda. Translated into French by S. S. Minn from Keikinzoku, 9: No. 36, 35-45(1959). 30p.

The effects of zirconium additions on the mechanical properties of magnesium and its alloys were studied, in particular, the tensile strength, hardness, shock resistance, and grain size. The zirconium addition lowers the grain size markedly below 0.3%, but the effect is negated above 0.6% because of the difference in melting point of zirconium and magnesium. Tensile strength increases with zirconium content. Hardness and shock resistance increase almost linearly with addition of zirconium. In Mg–Zn alloys the zirconium addition improves the mechanical properties and reduces grain size. Adding rare earths to magnesium improves its high-temperature properties; addition of zirconium to magnesium–rare earth alloys increases tensile strength, elongation, hardness, and shock resistance, and reduces the grain size. (T.R.H.)

11617 (HW-tr-23) DILATOMETRIC STUDY OF THE ZIRCONIUM–HYDROGEN SYSTEM. L. Espagno, P. Azou, and P. Bastien. Translated by Liz Appleby (Hanford Atomic Products Operation) from Mem. sci. rev. mét., 57: 254-9(April 1960). 13p.

A dilatometric study was made of the zirconium-hydrogen system using the noticeable elongation of the samples after hydrogen loading. It is shown that in this way a precise and direct determination of the lines of the diagram, especially for the solubility limit of hydrogen in α zirconium, the limit of the δ domain, and the eutectoid transformation (position in temperature, extent, and reversibility) can be arrived at. An abnormal transformation, characterized by a lowering of the coefficient of expansion between 250 and 350° on heating, which leads to a residual contraction at the end of the cycle, was observed. (T.R.H.)

11618 (JPLAI-TR-16) SURFACE TENSION AND HEAT VAPORIZATION OF METALS. S. N. Zadumkin. Translated by Joseph L. Zygielbaum from Doklady Akad. Nauk S.S.S.R., 112: 453-6(1957). 8p.

This report was previously abstracted from the original language and appears in NSA, Vol. 11, abstract no. 6400.

11619 (NP-tr-555) ON SOME INTERMETALLIC COMPOUNDS OF URANIUM WITH ELEMENTS OF GROUPS III AND IV. Aldo Iandelli and Riccardo Ferro. Translated by L. Pirt (U.K.A.E.A. Atomic Energy Research Establishment) from Ann. chim. (Rome), 42: 598-606(1952). 16p.

Uranium alloys containing high percentages of Ga, In, Tl, Si, Ge, or Pb were studied by x rays. In various cases the compounds UX_3 were identified as the last existing phases and their structure was determined. The behavior of magnesium with regard to uranium was also studied. It was

found that the two metals could not be combined. A brief discussion of the results obtained is given. (auth)

11620 (NP-tr-559) RARE METALS AND ALLOYS. E. M. Savitskii (Ye. M. Savitskiy). Translated from a publication of House of Technology, Moscow, 1959. 84p.

Data are summarized on the structure, properties, and industrial applications of rare metals and alloys containing rare metals. Rare metals are divided into five groups according to the similarity of their chemical and physical properties, joint occurrence in the raw ore materials, and methods of obtainment in the pure form. The groups include light rare metals, refractory metals, dispersed rare metals, rare-earth metals, and radioactive metals. (C.H.)

11621 (UCRL-Trans-473(L)) NON-LINEAR EQUATIONS FOR CREEP AND RELAXATION OF MATERIALS IN A COMPLEX STRESSED STATE. M. I. Rozovskii. Translated by Esther Goldberg from Zhur. Tekh. Fiz., 25: 2339-54(1955). 23p.

An analysis is presented of the nonlinear integral relations for processes of deformation in which the nonlinearity is specified. The relations are obtained for the case of a three-dimensional stressed state by calculating the functions of the instantaneous modulus of elasticity from the degree of deformation. For the first case an integral equation is proposed which is similar to an equation in the theory of plastic flow. It is established that, for good agreement in results when a problem is solved by the proposed theory and by the theory of plastic flow, it is necessary only that all components of the deformation tensor be proportional to one general parameter dependent only on time. It is also established that, if the component tensors of deformation and stress are calculated with the conditions of ordinary stress, results of solving equations from these two theories coincide. In generalization of the second appropriate case, the reaction time is found to be a function of stress magnitude. (J.R.D.)

11622 THE STRUCTURE OF Hf_5Sn_3. D. M. Bailey and J. F. Smith (Ames Lab., Ames, Iowa). Acta Cryst., 14: 57-8(Jan. 10, 1961). (In English) (IS-140)

An investigation was made to determine whether Hf_5Sn_3 would form in the $D8_8$ structure and, if so, to obtain some measure of the interstitial impurity content. An alloy on the tin-rich side of the stoichiometric ratio was prepared by arc melting under a helium atmosphere. The excess tin was dissolved in dilute HNO_3. Debye-Scherrer patterns taken on the residue showed qualitative agreement on both line position and intensity with the $D8_8$ structure. On the basis of analyses of the hafnium and tin, Hf_5Sn_3 contained less than one carbon atom per twenty unit cells and a total of only one impurity atom of any kind per ten unit cells. (M.C.G.)

11623 THE BERYLLIDES OF Ti, V, Cr, Zr, Nb, Mo, Hf, AND Ta. Allan Zalkin, Donald E. Sands, Ray G. Bedford, and Oscar H. Krikorian (Univ. of California, Livermore). Acta Cryst., 14: 63-5(Jan. 10, 1961). (In English)

A thorough x-ray-diffraction study was made of the beryllides of Ti, V, Cr, Zr, Nb, Mo, Hf, and Ta. Cell lengths were determined from powder patterns photographed with chromium or copper Kα x rays. Both the titanium and hafnium systems exhibited two different structures for the M_2Be_{17} composition. (M.C.G.)

11624 THE CRYSTAL STRUCTURE OF Zr_2Al. C. G. Wilson and D. Sams (Royal Military Coll. of Science, Shrivenham, Swindon, Wilts., Eng.). Acta Cryst., 14: 71-2(Jan. 10, 1961). (In English)

The crystal structure of the intermetallic compound Zr_2Al was determined from powder photographs using a sample of alloy prepared by arc melting in argon, annealing in vacuo for three weeks at 900°C, and then quenching. (M.C.G.)

11625 THE CRYSTAL STRUCTURE OF $CeCu_2$. Allen C. Larson and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 14: 73-4(Jan. 10, 1961). (In English).

The crystal structure of $CeCu_2$ was determined. A Ce–Cu alloy containing 66 at.% copper was melted in vacuum at 1081°C in a MgO crucible and slowly cooled. Crystals from this ingot were sealed in thin Pyrex tubes and examined with a precision camera. The crystals were found to be orthorhombic, space group Imma (if centric), with a = 4.43 ± 0.01, b = 7.05 ± 0.02, and c = 7.45 ± 0.02A. A 0kl Patterson projection was computed and the trial structure was quickly confirmed. (M.C.G.)

11626 THE β-Ag_3In PHASE. D. P. Morris and I. Williams (University Coll. of North Wales, Bangor). Acta Cryst., 14: 74(Jan. 10, 1961). (In English)

The structure of the β-Ag_3In phase was investigated in an alloy made from spectroscopically standardized silver and indium to the exact composition Ag_3In. High-temperature x-ray photographs confirmed that the β-phase structure was body-centered cubic, and the absence of extra reflections showed that the alloy was single-phase at 684°C, with a = 3.3682 A. (M.C.G.)

11627 SOME AB_3 COMPOUNDS OF THE TRANSITION METALS. A. E. Dwight, J. W. Downey, and R. A. Conner, Jr. (Argonne National Lab., Ill.). Acta Cryst., 14: 75-6 (Jan. 10, 1961). (In English)

Crystal structure data for fifteen AB_3 compounds of the transition metals were studied. The alloys were made by arc melting 3 to 5 of the elements in a water-cooled copper crucible. AB_3 compounds with the Cu_3Au-structure, Ll_2, space group Pm3m included: $ScRh_3$, $ScPd_3$, $ScPt_3$, YPd_3, YPt_3, $LaPd_3$, $HoPd_3$, $HoPt_3$, $ThRh_3$, URh_3, and UIr_3. AB_3 compounds with close-packed ordered structures included $ThPd_3$, VPd_3, VPt_3, and $HfAl_3$. (M.C.G.)

11628 THE CRYSTAL STRUCTURE OF URe_2. B. A. Hatt (Fulmer Research Inst., Ltd., Stoke Poges, Bucks, Eng.). Acta Cryst., 14: 119-23(Feb. 10, 1961).

The intermetallic compound URe_2 has two allotropic forms. Up to 180°C it has an orthorhombic structure, space group Cmca; above this temperature a C 14 structure is formed by a simple dilation of the unit cell. The lattice parameters at 20°C are a = 5.600, b = 9.180, and c = 8.460 A. For the hexagonal modification at 213°C a = 5.433, and c = 8.561 A. In both modifications the thermal expansion coefficients are positive along c and negative along a. (auth)

11629 THE CRYSTAL STRUCTURE OF $Zr(IO_3)_4$. Allen C. Larson and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 14: 128-32(Feb. 10, 1961).

$Zr(IO_3)_4$ is tetragonal, space group P4/n, with a = 8.38 ± 0.01, and c = 7.49 ± 0.01 A, and has two formula units per unit cell. The complete structure was determined from single crystal data obtained with a Geiger counter. The zirconium atoms are coordinated to eight oxygen atoms at the corners of a nearly perfect antiprism with an average Zr–O distance of 2.206 A. An interesting feature of the structure is that there are voids extending completely through the crystal along the fourfold inversion axis. (auth)

11630 SOME PROPERTIES OF ALKALI HALIDE CRYSTALS. E. A. Braun (Associated Electrical Industries, Ltd., Harlow, Eng.). Am. J. Phys., 29: 182-6(Mar. 1961).

The cohesive energy of alkali halide crystals can be ap-

proximated by treating it as arising from purely polar interactions. An attractive Coulomb potential and a repulsive overlap potential are the only terms that need to be considered. The phenomenon of coloration of alkali halides is described with particular emphasis on the mechanisms involved. As an example of luminescence, the luminescent process in thallium-activated alkali halides is discussed. (auth)

11631 THE INCREASE IN INTERNAL FRICTION ASSOCIATED WITH TEMPERATURE CHANGES IN URANIUM. Yu. N. Sokurskiĭ and Yu. V. Bobkov. Atomnaya Energ. 9: 392-8(Nov. 1960). (In Russian)

A semi-quantitative evaluation was made of the relation between the increment of internal friction and the rate of thermal cycling and vibration amplitude. The results of calculations are in good agreement with the experimental data. The influence of the initial state of the specimens on the increased internal friction at initial heating stages is analyzed. (tr-auth)

11632 MAGNETIC PROPERTIES OF URANIUM–TELLURIUM ALLOYS. [PART] II. W. Trzebiatowski and A. Sepichowska (Inst. of Physical Chemistry, Academy of Sciences, Wrocław, Poland). Bull. acad. polon. sci. Ser. sci. chim., 8: 457-60(1960). (In English)

Results of magnetic measurements on U–Te alloys with 33 to 54 at. % tellurium are presented. In this concentration range the uranium monotelluride constitutes the principal phase. Magnetic properties of UTe show a Curie point of about 104°K, reaching saturation magnetization at 85°K. Samples with higher or lower tellurium concentrations give much smaller magnetization values. Some numerical values of the magnetic measurements are compiled. (J.S.R.)

11633 THE DIRECT OBSERVATION WITH AN ELECTRONIC MICROSCOPE OF THE PHENOMENA WHICH ACCOMPANY THE RETURN TO EQUILIBRIUM OF A SOLID SOLUTION Al–Si 1,2%, DURING TEMPERING TREATMENTS FOLLOWING ANNEAL. Adrien Saulnier (Compagnie Pechiney, Chambery). Compt. rend., 251: 2160-2 (Nov. 14, 1960). (In French)

The return to equilibrium of supersaturated solutions is made in two consecutive steps. First there is precipitation of holes, formation of dislocation loops, and resorption of the loops. The second stage is the germination and growth of silicon particles. It does not appear that the germination is produced during the stage where the holes are in supersaturation in the lattice following annealing. (tr-auth)

11634 MICROGRAPHIC ASPECT OF A MAGNESIUM–ZIRCONIUM ALLOY HEATED IN HYDROGEN. Pierre Lelong, Jean Dosdat, Jacques Coghen, and Jean Hérenguel. Compt. rend., 251: 2698-2700(Dec. 5, 1960). (In French)

Electron microscopic examination permitted the exact definition of the form, distribution, and metallographic properties of zirconium hydride precipitated from a Mg–Zr alloy heated in hydrogen. The hydride is separated into platelets with hexagonal growth symmetry, indentical to those produced by precipitation in weakly hydrogenated zirconium. (tr-auth)

11635 AN INVESTIGATION OF THE THERMODYNAMIC PROPERTIES OF INDIUM-BISMUTH LIQUID ALLOYS. N. V. Alekseev, Ya. I. Gerasimov, and A. M. Evseev (Lomonosov, Moscow State Univ.). Doklady Akad. Nauk, S.S.S.R., 618-20(1960) Sept. 21. (In Russian)

The electromotive force in liquid In–Bi alloys was measured in the system $In_{liq}|I^{+}$ (in a melt of 11 wt.% KCl, 10% LiCl and 79% $ZnCl_2$) | $(N_1\ In + N_2Bi)_{liq}$, and activity coefficients for indium were calculated from the relation $\lg a_{In} = -Z\ Fe/4.576\ T$. The bismuth activities were calculated by graphical integration of the Gibbs-Duhem equation. These activity values were used to calculate ΔH and ΔS for indium and bismuth. The value of the integral heat of mixing decreased regularly with decreasing temperature. It is 597 cal/g-atom at 450°C, 440 cal/g-atom at 350°C, and 340 cal/g-atom at 270°C. The value of ΔH assumed both negative and positive values. (TTT)

11636 BERYLLIUM. M. K. McQuillan and T. W. Farthing. Endeavour, 20: No. 77, 11-18(Jan. 1961).

A general survey is presented of the properties, production, toxicology, and uses of beryllium. (T.R.H.)

11637 SHIELDING AGAINST CORROSIVES AND RADIOACTIVITY. Alfred P. Knapp (Knapp Mills Inc.). Ind. Eng. Chem., 53: 75A-76A(Mar. 1961).

Insmetals (International Shielding Metals) are metals lead-surfaced for γ shielding. The base metals are aluminum, aluminum alloys, copper, copper alloys, carbon steel, stainless steel, nickel alloys, and stainless-clad carbon steel. The material is corrosion-resistant, easy to inspect and maintain, economical, and can withstand temperatures up to 621°F. (T.R.H.)

11638 STRUCTURAL PROBLEMS OF MELTS. S. F. Khokhlov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 80-5(Nov.-Dec. 1960). (In Russian)

The liquid state, being an intermediary one between solids and gases, makes it difficult to derive generalized structural laws. On the basis of experimental data it may be regarded as a dynamic aggregate of micro-regions in mobile equilibrium, depending on the continuous transport of atoms or groupings of atoms from one region to the other. The dimensions of these micro-regions are determined by the temperature of the liquid, i.e., by the thermal energy of the component particles, while the structure depends on the symmetry of the field of force of the atoms and the energy of their interactions. Thus the melting process consists of the transformation of the single molecules in the crystal into a part of interconnected serial units. Near the melting point the phase diagram is only a partial help for determining the structure of the system because the phase change causes a change in the electron density distribution and with it a modification of the type of the bond. Eutectic mixtures that are similar to pure components may be considered as a special case of stratification. The initial atoms become polarized in view of the slight interaction between them. Very different atoms, such as iron and alkali or alkaline earth metals, which are only slightly polarized, become simply stratified without forming eutectics. 22 references. (TTT)

11639 THE MACROMOLECULAR STRUCTURE OF LIQUID METALS AND THE INTERACTION OF THE MACROMOLECULES. Yu. A. Klyachko. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 85-7 (Nov.-Dec. 1960). (In Russian)

The theory of the macromolecular and micelle type structures of liquid and solid metals was previously developed. According to that theory the dimensions of the smallest-order region of the metallic system are determined by the mean free path of the electron within the lattice, which is about 10^{-10} cm at room temperature but reaches macroscopic values such as 10 cm at very low temperatures. The interaction between the macromolecules is primarily based on the attraction-dispersion forces, which are quite large in the case of metals in view of the presence of large numbers of electrons in the macromolecules. For liquid metals, the complete range from

the melting to the boiling point must be investigated—this very interval serves as a measure of the macromolecular character of the system. The theory is based on the experimental study of electrical conductivity, viscosity, galvanomagnetic effects, and optical absorption phenomena in thin liquid-metal films. (TTT)

11640 APPLICATION OF NEUTRON SPECTROSCOPY FOR THE STUDY OF MATTER IN THE SOLID AND LIQUID STATES. M. M. Bredov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 87-9(Nov.-Dec. 1960). (In Russian)

In order to determine the structure of matter on the atomic scale, the wavelength of the radiation used should be of the order of the interatomic distances, i.e., several angstroms, with an energy of several hundred ev. Neutrons and protons satisfy these conditions but on the basis of their penetrations thermal neutrons are best suited for such studies; they have mean free paths of the order of a few cm to a few tens of cm and the neutral nucleon, which has a magnetic moment, interacts with matter. Among the problems that can be solved by means of neutron spectroscopy are: the determination of the position of light atoms in materials including atoms of the heavy elements; order-disorder phenomena in alloys containing transition metals; determination of the mean free path of phonons; behavior of liquids near the critical temperature; defect concentration in crystals; and study of the short-range order phenomena in liquids. Kinetic parameters such as viscosity and diffusion coefficients may also be measured by this method. Although experimental data are scarce at present, the increased availability of power reactors and of other strong neutron sources holds the promise that the structure of liquids will be much better known in the near future, thanks to experimental work on the field of neutron spectroscopy. (TTT)

11641 KINETIC PROPERTIES OF LIQUID METAL ALLOYS. D. K. Belashchenko. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 89-93(Nov.-Dec. 1960). (In Russian)

Attempts were made to explain the properties of eutectoid liquid alloys by assuming micro-nonhomogeneities in their structure. According to this, the system consists of alternating regions enriched in one or the other of the components. Calculations indicated that such region could include several thousands of atoms. However, this theory is thermodynamically untenable: the formation and segregation of such regions should be accompanied by a strong reduction of the entropy and an increase of the free energy of the interphase, to be compensated by a decrease of the internal energy. This energy decrease was found to be insignificant in eutectoid systems, being zero in the case of bismuth–cadmium and having a negative sign in the case of bismuth–lead. In studying noble metals such as silver dissolved in lead and bismuth, it was found that the charge is less than unity; even gold becomes soluble in common metals with a negative charge. The noble metals act as electron acceptors. The behavior of liquid alloys is currently being investigated at the Moscow Steel Institute. There is a great need for an all-encompassing theory of metallic systems. (TTT)

11642 THE STRUCTURE OF LIQUID METALS WITH REFERENCE TO THEIR ELECTRONIC COMPOSITION. V. K. Grigorovich. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 93-109(Nov.-Dec. 1960). (In Russian)

In the theory of the liquid state, the melting process and the properties of the liquid are considered from the viewpoint of the critical concentration of vacancies and the destruction of the ordered structure without specifically examining the structure of the liquid metals formed. This structure depends on the outer electron shell of the metal. A coordination number of 8 and a short-range order corresponding to a volume-centered cubic unit cell are dependent in the case of alkali metals on singly charged ions in the liquid and on completely filled p subshells. The original coordination number of 8 and the interatomic distances are preserved during the melting of the alkaline earth metals calcium, strontium, barium, and radium. The transition metals and also iron and manganese behave similarly. Upon extreme heating the main bond is destroyed and the system tends to become as dense as possible with a coordination number of 12. The metals of the 7th and 8th groups, which have the most closely packed structure, retain the same structure in the liquid state, similar to gold. (TTT)

11643 MASS SPECTRA AND THE STRUCTURE OF METALLIC VAPORS. G. M. Martynkevich. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 145-7(Nov.-Dec. 1960). (In Russian)

In the mass spectra of liquid-metal vapors, which are considered to be monoatomic, polyatomic ions were found previously but the possible secondary processes within the ion source of the mass spectrograph were not considered. The conclusion was drawn that the presence of such atoms is due to the evaporation of molecular complexes from the solution. This problem was studied while investigating the mass spectra of the vapors of liquid copper, indium, bismuth, and gallium. Formulas were derived to explain the correspondence between the structures of the liquids and the vapors. The presence of two-atomic complexes is explained on a theoretical basis. The solid-vapor equilibrium is illustrated by previously published data on iodine. The possibility of realizing short-range order in liquid metals is indicated. The mass spectrographic study of the evaporation mechanism of liquid metals and alloys should find application in vacuum metallurgy. (TTT)

11644 IMMISCIBILITY AND THE SYSTEM LANTHANUM OXIDE–BORIC OXIDE. Ernest M. Levin, Carl R. Robbins, and Jon L. Waring (National Bureau of Standards, Washington, D. C.). J. Am. Ceram. Soc., 44: 87-91(Feb. 1961).

The phase equilibrium diagram for the system La_2O_3–B_2O_3 was determined experimentally. The compounds $La_2O_3 \cdot 3B_2O_3$ and $La_2O_3 \cdot B_2O_3$ melt congruently at 1141 ± 5°C and 1660 ± 15°C, respectively. At 1488 ± 5°C, $La_2O_3 \cdot B_2O_3$ inverts from the aragonite type structure to a high-temperature form. Trilanthanum borate, $3La_2O_3 \cdot B_2O_3$ melts incongruently at 1386 ± 5°C to give liquid and La_2O_3. No solid solutions exist in the system. A region of liquid immiscibility exists in the system and extends at 1136 ± 5°C from almost pure B_2O_3 to 21.5 mole % La_2O_3. The experimental value for the extent of immiscibility agrees with that calculated from theoretical considerations. A second method for estimating immiscibility in the system is demonstrated, which requires experimentally only the determination of the index of refraction of the modifier-rich liquid. Principles governing immiscibility are discussed. (auth)

11645 DISLOCATION CONTRIBUTIONS TO THE MODULUS AND DAMPING IN COPPER AT MEGACYCLE FREQUENCIES. G. A. Alers (Ford Motor Co., Dearborn, Mich.) and D. O. Thompson. J. Appl. Phys., 32: 283-93 (Feb. 1961).

The three elastic moduli of 99.999+% pure copper and their associated internal frictions have been measured at

megacycle frequencies between 4.2 and 250°K both before and after fast neutron bombardment. The changes produced by the irradiation were used to determine the dislocation contributions to the damping and moduli as a function of frequency and temperature. The dislocation damping showed the maximum predicted by Granato and Lücke to arise from the heavily damped bowing of dislocation loops. By calculation of the resolved shear stress factors and measurement of the dislocation density by etch pit counts, it was possible to determine the coefficient B, which describes the viscous drag on a moving dislocation, as well as the effective loop length l. The factor B was found to be 8×10^{-4} dyne/sec/cm^2 at 300°K and to decrease linearly with decreasing temperature, as predicted by Leibfried. The effective loop length appeared temperature independent and had a value of 3×10^{-4} cm in the sample examined most carefully. Cold-worked single crystals of the same copper were also studied. Two Bordoni type peaks in the damping vs. temperature curves were located at 135 and 60°K at 10 Mc. Activation energies of 0.113 and 0.05 ev were determined by using low-frequency data taken from the literature. (auth)

11646 PROPERTIES OF THIN ANTIMONY FILMS DEPOSITED IN HIGH VACUUM. George A. Condas and Frederick O. Wooten (Univ. of California, Livermore). J. Appl. Phys., 32: 323-4(Feb. 1961).

The properties of thin antimony films deposited at pressures down to 10^{-9} mm Hg and below are described. Depositions at 10^{-7} mm Hg and higher confirm the report that the evaporation rate of 100 A/sec controls the quality of the film, but with rates of 1 or 2 A/sec at 10^{-8} mm Hg only 3 out of 7 depositions produced heterogeneous films. Of 10 depositions at 10^{-9} mm Hg and less, no heterogeneous films were produced, even with rates of 0.1 to 1 A/sec. The purity did not affect film quality. The high evaporation rate prevents deleterious reactions of the antimony with atmosphere impurities, probably water. (T.R.H.)

11647 THE NIOBIUM–HYDROGEN SYSTEM. S. Komjathy (IBM Corp., Chicago). J. Less-Common Metals, 2: 466-80(Dec. 1960).

Niobium–hydrogen equilibrium was studied in the temperature range of 300 to 1500°C between 0 and 760 mm Hg equilibrium H_2 pressure by the Sieverts technique. Continuous solid solution is formed in this range, which exhibits b.b.c. structure with lattice parameter increasing with increasing hydrogen content. The formation of the solid solution is exothermic; the heat of solution increases with increasing hydrogen content. Below 300°C, x-ray-diffraction analysis and metallographic examination revealed the existence of a nonclassical phase transformation, which is possibly martensitic or order-disorder type. (auth)

11648 ON THE ENERGY OF THE INTERSTITIAL ATOM IN GRAPHITE. Tadao Iwata, F. Eiichi Fujita, and Hideji Suzuki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 197-205(Feb. 1961). (In English)

Self- and migration energies associated with interstitial carbon and xenon atoms in graphite are calculated, taking account of the relaxation around the interstitials. Assuming that the graphite lattice consists of thin elastic plates held together by the weak interaction forces and subjected to the transverse force by the interstitial atom, the strain form is obtained by solving the equations for the bending plates. Then, employing a suitably chosen interaction potential between the interstitial and all other atoms, the relaxation and the energies associated with the interstitials are calculated. In case of the carbon atom, the self-energy is 2.5 ev, the migration energy is 0.016 ev, and the ratio of strain energy to the total self-energy is 0.49, and in the case of xenon they are 15.1 ev, 0.03 ev, and 0.79, respectively. (auth)

11649 OBSERVATION OF LATTICE DEFECTS IN GRAPHITE BY ELECTRON MICROSCOPY, PART I. F. Eiichi Fujita and Kazuhiko Izui (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 214-27 (Feb. 1961). (In English)

Lattice defects which can a priori exist in graphite crystals and be observed by means of electron microscopy, mainly dislocations, are reported. Four kinds of dislocations and their combination predicted from the crystal structure are observed through the diffraction contrast and the disturbances in the moiré pattern such as the extra terminating half lines and the line shift. Their network arrangements and movement are also found. The line grating model reveals the relation between the line shift of the moiré fringes and the Burgers vector of the glissile dislocations. New origins of extra terminating half lines are considered too. (auth)

11650 A DIFFRACTION PATTERN CAUSED BY TEMPERATURE DIFFUSE SCATTERING. I. GENERAL THEORY. Yoshiro Kainuma (Nagoya Univ., Japan). J. Phys. Soc. Japan, 16: 228-41(Feb. 1961). (In English)

When diffuse x rays caused by scattering in a thermally vibrating crystal are scattered again in the same crystal, a new diffraction pattern similar to Kossel pattern is produced. The properties of the new pattern are discussed by the use of the perturbation theory of x-ray scattering in a crystal. According to the present theory, the signs of crystal structure factor can be determined by examining the new pattern produced at an appropriate crystal orientation, provided relative values of elastic constants are available. (auth)

11651 INELASTIC SCATTERING OF THERMAL NEUTRONS BY PARAMAGNETIC IONS. Soichiro Tosima (Kyus[h]u Univ., Fukuoka). J. Phys. Soc. Japan, 16: 241-50(Feb. 1961). (In English)

For the magnetic scattering of thermal neutrons by paramagnetic ions with discrete energy levels, Trammell's theory is extended to include the inelastic scattering, and the scattering cross section of Eu^{3+}, Sm^{3+}, Co^{2+} in oxide and fluoride, and Fe^{2+} in oxide is estimated. In these ions the cross sections appreciably include the inelastic parts and depend on the temperature and the energy of the incident neutrons, that is, the cross sections suddenly increase when the energy of the neutron exceeds the level separations. (auth)

11652 ZIRCONIUM ALLOYS: CORROSION RESISTANCE AND STRENGTH ARE IMPROVING. R. J. Van Thyne (Illinois Inst. of Tech., Armour Research Foundation, Chicago). Materials in Design Eng., 53: No. 2, 10-13(Feb. 1961).

A review is presented on the properties of zirconium and zirconium alloys and their possible applications in fields other than reactors, especially in the chemical processing industries. Resistance to CO_2 corrosion at temperatures up to 930°F can be obtained by adding 0.5% each of copper and molybdenum to zirconium. Tin and aluminum additions to zirconium stabilize the high-strength α phase up to 1200°F. The properties of Zircaloys and Al-Zr and Sn-Zr alloys at 1200°F are tabulated. However, most uses outside the reactor field are limited to commercial zirconium containing 2% hafnium. The corrosion rates of zirconium by a large number of acids, alkalis, chlorides, etc., are tabulated. On the basis of its corrosion resistance, zirconium may replace stainless steel or titanium in some applications. The

use of zirconium as a getter material for oxygen and in flashbulbs is discussed. (D.L.C.)

11653 PRESENT KNOWLEDGE OF THE α-β ALLOTROPIC TRANSFORMATION IN URANIUM. M. Englander (Centre d'Études Nucléaires, Saclay, France). Met. ital., 51: 497-504(1959). (CEA-1508). (In French)

The conditions under which the problem of the α-β allotropic uranium transformation is posed are shown. The qualitative reasons for which it is possible to assume that, in unalloyed uranium, the germination of the new phase occurs by a coherent mechanism, and the growth of the new phase at the expense of the surrounding one occurs either by a martensitic type shear mechanism or by thermal diffusion if the temperature and the impurity level are sufficiently high are given. (auth)

11654 PROPERTIES OF BERYLLIUM SHEET. Metal Progr., 79: 192; 194; 196(Mar. 1961).

An investigation was made to determine the effects of surface conditions on the tensile properties of beryllium sheet over a wide temperature range. Specimens with etched surfaces were stronger and more ductile than specimens with other surfaces. Scribe-marking reduced these properties, particularly ductility. As-received specimens fractured primarily along the $(11\bar{2}0)$ planes. Data indicated that beryllium sheet with a defect-free surface loaded in uni-axial tension in the longitudinal grain direction does not show undue notch sensitivity. (M.C.G.)

11655 THERMAL STRESS IN CONCRETE. I. W. Hannah (Simon-Carves, Ltd., Cheadle Heath, Ches, Eng.). Nuclear Eng., 6: 69-74(Feb. 1961).

A laboratory research program on the nature and effect of thermal stresses in concrete is described. The first experimental work undertaken was to define whether shields in general, and Hunterston's in particular, could be regarded as reinforced concrete or whether insufficient reinforcement was provided to alter the structural behavior from that of an unreinforced concrete vessel. Taking bending as a criterion, the minimum percentage area of reinforcement that would permit multiple cracking prior to failure in a section of beam subjected to a constant bending movement was measured. The tests are described, and the effects of temperature on flexural strength, behavior under short-term temperature gradients and linear temperature gradients, are given. (T.R.H.)

11656 PREPARATION AND CHARACTERISTICS OF ThO_2–Bi SLURRIES. W. F. Kenney and H. Susskind (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng., 9: 211-20(Feb. 1961). (BNL-4535)

The uniformity and stability of ThO_2–Bi dispersions (with 350 ppm each of magnesium and zirconium) were measured in 50-lb batches containing up to 11.5% ThO_2 and also in circulating experiments carried out in a ½-in. IPS pumped loop at ThO_2 concentrations up to 7.4%. Good results were obtained in all experiments where gas entrainment was prevented or eliminated. (auth)

11657 NUCLEAR MAGNETIC RESONANCE IN TANTALUM METAL. J. I. Budnick (IBM Research Lab., Poughkeepsie, N. Y.) and Lawrence H. Bennett. Phys. and Chem. Solids, 16: 17-38(Nov. 1960). (In English)

The nuclear magnetic resonance of Ta^{181} was observed in tantalum metal. The sample was a stack of high-purity foil that was degassed and annealed. No resonance was observed in tantalum metal powder. (auth)

11658 INTERMETALLIC COMPOUNDS BETWEEN LANTHANONS AND TRANSITION METALS OF THE FIRST LONG PERIOD. I. PREPARATION, EXISTENCE AND STRUCTURAL STUDIES. K. Nassau, L. V. Cherry, and W. E. Wallace (Univ. of Pittsburgh). Phys. and Chem. Solids, 16: 123-30(Nov. 1960). (In English)

Alloys have been prepared with compositions corresponding to the formulas AB_5, AB_2, AB and A_2B, in which A is Y, La, Ce, Sm, Gd, Dy, or Ho and B is Mn, Fe, Co, or Ni. Samples were prepared by the technique of levitation melting. Powder diffraction patterns were obtained to establish whether or not the various alloys existed in the form of intermetallic compounds. Extensive compound formation tendency was exhibited by all the lanthanons except La. All AB_2 type compounds were found to exist in the $MgCu_2$ structure. The AB_5 type compounds occurred either in the $CaCu_5$ structure or in an unsolved orthorhombic structure. Some AB and A_2B compounds may exist. Confirmation awaits interpretation of their diffraction patterns. Factors affecting the existence of these compounds and their structural parameters are discussed. (auth)

11659 INTERMETALLIC COMPOUNDS BETWEEN LANTHANONS AND TRANSITION METALS OF THE FIRST LONG PERIOD. II. FERRIMAGNETISM OF AB_5 COBALT COMPOUNDS. K. Nassau, L. V. Cherry, and W. E. Wallace (Univ. of Pittsburgh). Phys. and Chem. Solids, 16: 131-7 (Nov. 1960). (In English)

Magnetizations were determined at various temperatures for a series of substances represented by the type formula ACo_5, in which A is either Ce, Sm, Gd, Dy, Ho, Y, or a mixture of Gd and Y. The purpose of the study was to ascertain whether or not the atomic moments are aligned at sufficiently low temperatures and if so to elucidate as far as possible the nature of the alignment. The magnetization-temperature curves for YCo_5 and $SmCo_5$ indicate them to be normal ferromagnetic compounds at least down to 80°K, with Curie points at 975 and 1015°K, respectively. Their saturation magnetic moments indicate that the cobalt moments are aligned ferromagnetically. The curves for the other compounds show well-defined Curie temperatures ranging from 685 to 1125°K but are unusual in that below a certain temperature, ranging up to 575°K, magnetization shows an anomalous fall with diminishing temperature. Analysis of these results and the observed saturation magnetizations show that the moments are aligned, but not ferromagnetically. The compounds appear to be ferrimagnetic. A discussion of the possible modes of alignment is presented. Thermomagnetic analysis shows that in most instances the compounds decompose when heated to the point at which the alignment of the atomic moments is destroyed. (auth)

11660 THE GROUP THEORETICAL ANALYSIS OF α-URANIUM. M. Suffczynski (Imperial Coll. of Science and Tech., London). Phys. and Chem. Solids, 16: 174-6 (Nov. 1960). (In English)

The free-electron approximation for α-uranium is investigated. The difficulties of approaching the band structure of uranium are discussed. The representations of the double groups of α-uranium are given. (auth)

11661 HEAT CAPACITY, THERMAL EXPANSION AND ELECTRICAL RESISTIVITY OF AN 8 a/o ALUMINUM–PLUTONIUM (DELTA-PHASE STABILIZED) ALLOY BELOW 300°K. T. A. Sandenaw (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 16: 329-36(Nov. 1960). (In English)

The heat-capacity and thermal-expansion data for a delta-phase stabilized aluminum-plutonium alloy are represented by curves and least-squares equations for the temperature region below 300°K. A curve for electrical resistivity of the alloy is given. The results of physical measurements

indicate the major role of time-dependent cooperative phenomena. Values of the electronic contribution coefficient, Debye characteristic temperature, entropy, and enthalpy are reported, and comparisons are made of the observed behavior of high-purity plutonium and the stabilized alloy. (auth)

11662 THE STABILIZING FIELD OF THE MAGNETIC AFTER-EFFECT IN SILICON-IRON AT HIGH TEMPERATURES. G. Hellbardt. Tech. Mitt Krupp, 18: 25-8(Aug. 1960). (In German)

In an iron–silicon alloy the stabilizing field of the well-known after-effect at higher temperatures was measured for temperatures of about 500°C. The measurement consists of an oscillographic recording of the function B(H) before and after stabilization has occurred. For low inductions the results are in agreement with the theory of Dietze who suggested vacancies to stabilize the domain walls. But in contradiction to this theory the stabilization field only vanishes above 9000 G after assuming a second maximum. The latter may be attributed to grain-boundary relaxation. Probably both effects are superimposed in iron–silicon at high temperatures. (auth)

11663 ON THE SOLUTION RATE OF DIFFERENT FERRO-CHROMIUM ALLOYS IN STEEL BATHS AND THE BEHAVIOR OF CHROMIUM CARBIDES DURING THE DISSOLVING PROCESS. K. Blankenstein and E. Plöckinger. Tech. Mitt. Krupp, 18: 37-43(Nov. 1960). (In German)

Laboratory tests were conducted to determine the solution rate of different Fe–Cr alloys and of Cr_7C_3 in nonboiling steel baths containing 0.3 and 1.0% carbon. Principles applying to the dissolution behavior of Cr alloys with varying carbon contents are given. Dissolution of the carbides introduced with the Cr alloys into the melt was elucidated by microscopical examination and residue isolation. Conclusions are drawn for the steelworks practice. (auth)

11664 INVESTIGATIONS ON OXIDE INCLUSIONS IN FERRO-CHROMIUM ALLOYS. G. Siebert and E. Plöckinger. Tech. Mitt. Krupp, 18: 44-53(Nov. 1960). (In German)

General remarks are made on the production of chromium alloy steel poor in inclusions. Previous knowledge concerning the contents of inclusions in commercial ferrochromium alloys is summarized. Production of ferrochromium alloys with predetermined contents of inclusions is described. Results of the inclusion tests made with silicon-bearing and silicon-free ferrochromium alloys are given. The formation of inclusions and their reaction to heat-treatment are discussed. (auth)

11665 POTENTIOSTATIC EXTRACTION AND ANALYTICAL INVESTIGATION OF INCLUSIONS IN FERRO-CHROMIUM-ALLOYS. Christa Ilschner-Gensch. Tech. Mitt. Krupp, 18: 54-63(Nov. 1960). (In German)

An investigation was made of low-carbon alloys. Electrolytical extraction of oxide inclusions and oxides plus carbides was carried out. X-ray, microscopical, and microchemical analyses of the residues were made and discussed. The investigation of high-carbon alloys included preparation of test specimens, electrolytical extraction of the oxide inclusions, and x-ray and microscopical analyses of the residues. (auth)

11666 INVESTIGATIONS INTO THE FORMATION AND PRECIPITATION OF DEOXIDATION PRODUCTS. M. Wahlster and E. Plöckinger. Tech. Mitt. Krupp, 18: 64-80(Nov. 1960). (In German)

Opinions held up to now regarding the formation and precipitation of the products of deoxidation during the precipitation deoxidation of steel are discussed. Investigations into the mechanism of the formation of the oxide phases in molten steel, taking account of the reactions between the oxygen in the iron and silicon, aluminum, titanium, zirconium, and some of the commercial deoxidation alloys were made. Results were obtained with melts prepared in the laboratory and plain carbon steel melts produced in the 3-ton electric arc furnace. Quantitative examination of the precipitation phenomena in the pouring ladle and in the ingot as dependent on the chemical composition and the physical properties of the deoxidation products is described. The influence of laminar and turbulent flow is pointed out. Conclusions are drawn for the steelworks practice. (auth)

11667 ON IRON–COBALT PERMANENT MAGNET ALLOYS WITH ADDITIONS OF VANADIUM AND CHROMIUM. W. Baran, W. Breuer, H. Fahlenbrach, and K. Janssen. Tech. Mitt. Krupp, 18: 81-90(Nov. 1960). (In German)

Magnetic and mechanical properties of a heavily cold-worked (approximately 92.5% reduction of cross section) iron-cobalt-vanadium-chromium permanent magnet alloy (52% Co, 8% V, 4% Cr, and balance Fe) were determined. Electron-microscopic pictures indicate the existence of a fine two-phase structure. The magnetization is mainly caused by rotation processes. The permanent magnet state is caused by a uniaxial anisotropy, the origin of which may be more readily explained by strain than by form anisotropy. (auth)

11668 ON IRON–COBALT PERMANENT MAGNET ALLOYS WITH ADDITIONS OF VANADIUM AND CHROMIUM. H. Fahlenbrach. Tech. Mitt. Krupp, 18: 91-6(Nov. 1960). (In German)

Possibilities for the use of an iron-cobalt permanent magnet alloy with additions of vanadium and/or chromium are discussed. The high raw material costs and the manner of fabrication (heavy cold-working) limit its use to very small magnets. The high remanence and little coercive force require a small cross section and a great length of the magnets. When these conditions are fulfilled, this alloy has advantages over other permanent magnet materials because of the economy in production. (auth)

11669 EFFECT OF STRUCTURE AND PURITY ON THE MECHANICAL PROPERTIES OF COLUMBIUM. A. L. Mincher and W. F. Sheely (Union Carbide Metals Co., Niagara Falls, N. Y.). Trans. Met. Soc. AIME, 221: No. 1, 19-25(Feb. 1961).

Mechanical properties of niobium were studied over the temperature range of –196 to 1093°C. The decreased strengthening influence of cold-work at temperatures below ambient was interpreted in terms of the Peierls-Nabarro effect. Maxima in the rate of strain hardening observed during tensile testing in the range 250 to 600°C were correlated with interstitial impurities to indicate the temperature ranges at which carbon, oxygen, and nitrogen, respectively, are responsible for strain aging. (auth)

11670 ROOM-TEMPERATURE DEFORMATION AND FRACTURE CHARACTERISTICS OF LITHIUM–FLUORIDE SINGLE CRYSTALS. W. L. Phillips, Jr. (E. I. du Pont de Nemours & Co., Wilmington, Del.). Trans. Met. Soc. AIME, 221: No. 1, 35-44(Feb. 1961).

The deformation and fracture characteristics of lithium fluoride single crystals stressed in compression at room temperature were studied. In as-cleaved specimens the stress-strain curves were variable; two types of {1 1 0} fractures were observed in the vicinity of kink bands. The stress-strain curves of annealed crystals were reproducible; {1 0 0} cracks formed which propagated along the {1 0 0}

and {1 1 0} planes. The deformation and fracture characteristics were affected by quenching and x-ray irradiation. (auth)

11671 URANIUM SOLUBILITY IN BISMUTH-BASE LIQUID SOLUTIONS. A. F. Weinberg, R. J. Van Thyne, and R. E. Steiner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Met. Soc. AIME, 221: No. 1, 83-90(Feb. 1961).

Uranium solubility in molten bismuth was determined in the temperature range 350 to 600°C, varying from 0.09 to near 2 wt.%, respectively. Zirconium and magnesium, simulated fission products, and sodium were found to increase or decrease uranium solubility in bismuth in the temperature range 370 to 420°C, depending upon the addition or temperature. Data were obtained by both chemical analysis of samples obtained by filtration from saturated melts and by measurement of the variation of electrical resistance with temperature. (auth)

11672 RARE EARTH GALLIUM COMPOUNDS HAVING THE ALUMINUM–BORIDE STRUCTURE. S. E. Haszko (Bell Telephone Labs., Murray Hill, N. J.). Trans. Met. Soc. AIME, 221: No. 1, 201-2(Feb. 1961).

Crystallographic data are presented on several new rare-earth Ga_2 compounds having the AlB_2 structure. The compounds involved were: Y, La, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, and Er. Relative intensities were computed for $DyGa_2$ and CrKα radiation. (T.R.H.)

11673 OBSERVATIONS ON THE Ti–Zr SYSTEM. E. Ence (Republic Aviation Corp., Farmingdale, L. I.) and H. Margolin. Trans. Met. Soc. AIME, 221: No. 1, 205-6 (Feb. 1961).

To study the effect of zirconium on Ti–Cu–Al alloys, Ti–Zr alloys were examined for ordering or compounds at 24.1, 32.2, 38.8, and 49.0 wt.% zirconium. Buttons prepared by nonconsumable arc were hot-rolled to 6-mm rods at 600 to 700°C and quenched. Annealing times were: 700°C for 7 days; 600°C for 14 days; 575°C for 1 and 2 months; 525°C for 2 months; and 500°C for 2 months. Microstructure and x-ray diffraction studies showed no phases other than α or β. Small amounts of β were detected in the 49% zirconium. Temperatures for the β and α transus boundaries, considerably lower than those of Hayes et al., are indicated. The shifts are explained by a higher interstitial contaminant level in the earlier work. (T.R.H.)

11674 THE MAGNESIUM-RICH REGION OF THE MAGNESIUM–YTTRIUM PHASE DIAGRAM. D. Mizer and J. B. Clark (Dow Metal Products Co., Midland, Mich.). Trans. Met. Soc. AIME, 221: No. 1, 207-8(Feb. 1961).

The magnesium-rich region of the Mg–Y system was studied by metallography and thermal analysis to determine more accurately the liquidus, solidus, and solvus of the magnesium solid solution. The maximum solid solubility of yttrium in magnesium is ~12.6 wt.% at the eutectic temperature of 1050°F. The eutectic composition of 26 wt.% yttrium agreed with data of other workers as did the temperature of the eutectic horizontal, 1050°F. The appearance of the precipitate is markedly dependent on time and temperature of aging and the amount of solute available. (T.R.H.)

11675 CONDUCTIVITY INDUCED BY ELECTRON BOMBARDMENT IN CdTe AND ZnSe. A. V. Simashkevich, M. V. Kot, and L. M. Panasyuk (Kishinev State Univ., [USSR]). Ukrain. Fiz. Zhur., 5: 504-8(July-Aug. 1960). (In Ukrainian)

The results of measurements of induced conductivity in thin CdTe films and single CdTe and ZnSe crystals due to bombardment by electrons with an energy up to 3 to 3.5 kev are presented. The dependence of the induced conductivity on the current intensity and energy of the primary electrons was investigated. In general, the induced conductivity was found to be linearly dependent on the current intensity of the primary electrons. With an increase in primary electron energy, the induced conductivity rose more rapidly. Apparently, this was due to the increase in the depth of electron penetration. (auth)

11676 THE BERYLLIUM BORIDE BeB_{12} WITH β-BORON STRUCTURE. H. J. Becher (Technische Hochschule, Stuttgart). Z. anorg. u. allgem. Chem., 306: 266-72(1960). (In German)

The boride BeB_{12} is formed by heating rhombohedral γ boron with 4 to 12% beryllium. The powder diagram of the product corresponds to the diagram of tetragonal β boron, using stoichiometric quantities of boron and beryllium. Excessive γ boron remains unchanged; a moderate excess of beryllium may be extracted by acids. The structure of BeB_{12} may be described by the same arrangement of B_{12}-icosahedrons as in tetragonal boron with the beryllium atoms occupying half of the holes between the icosahedrons. (auth)

11677 MAGNETIC SECONDARY EFFECT OF AGE HARDENED NICKEL–BERYLLIUM AND IRON–MOLYBDENUM ALLOYS. Hans Dieter Hahlbohm and Karl Heinz Börnig (Physikalisch-Technische Bundesanstalt, [Berlin]). Z. Metallk., 51: 708-10(Dec. 1960). (In German)

It has been observed in age-hardened alloys of the systems Ni–Be and Fe–Mo that the magnetic fatigue corresponds to a fluctuation after-effect which is the result of a delayed Barkhausen-effect. During the age-hardening process the after-effect constant S_γ changes as the coercitive force and opposite to the saturation magnetization and the Curie temperature. The change is proportional as long as the age-hardening process is free of coagulation and recovery. (auth)

11678 MELT DIAGRAM OF TANTALUM–VANADIUM ALLOY. V. N. Eremenko, L. A. Tret'yachenko, and R. I. Yakhimovich. Zhur. Neorg. Khim., 5: 2290-3(Oct. 1960). (In Russian)

Metallographic, microhardness, and x-ray diffraction analyses were made of the tantalum–vanadium alloys, and the melting points were determined. Phase diagrams were plotted for a continuous series of solid solutions formed. (R.V.J.)

11679 ON THE PREPARATION OF SOLID SOLUTIONS OF Y_2O_3–Sc_2O_3 BY THERMAL DECOMPOSITION OF ISOMORPHOUS CO-PRECIPITATED YTTRIUM AND SCANDIUM OXALATES. Ya. S. Savitskaya, M. A. Gurevich, S. V. Kalabukhova, and S. I. Sitnikova. Zhur. Neorg. Khim., 5: 2300-6(Oct. 1960). (In Russian)

Solid solutions of Y_2O_3–Sc_2O_3 were prepared by thermally decomposing co-precipitated oxalates $(Y,Sc)_2(C_2O_4)_3 \cdot \underline{n}H_2O \xrightarrow{t^\circ} (Y,Sc)_2O_3 + CO + CO_2 + \underline{n}H_2O$. It is shown that the method achieves a continuous series of solid solutions with lattice-period variability from a = 10.61 kX (for pure Y_2O_3) up to a = 9.85 kX (for pure Sc_2O_3). The method is suggested for preparing oxide solutions of various other systems. (R.V.J.)

11680 STUDIES OF TERNARY Cr–Nb–Mo ALLOY AT CHROMIUM AND NIOBIUM ANGLE. N. N. Kurnakov, and M. Ya. Troneva. Zhur. Neorg. Khim. 5: 2403-09(Nov. 1960). (In Russian)

Melting point, macro- and microstructure, and partial x-ray diffraction studies were made of the ternary Cr–Nb–Mo alloy. The microstructure showed that the ternary α

solid solution of chromiun, niobium, and molybdenum was found in the chromiun and niobium corner. The region expands with the increase of molybdenum. A large two-phase region of Cr_2Nb and ternary α solid solution is adjacent to chromium–niobium side. The boundary was found for the Cr_2Nb two-phase region and α solid solution for 1500 to 1000°C. The x-ray studies uncovered the ternary solid solution of Cr, Nb, Mo, and Cr_2Nb compounds. The microhardness of the alloys indicates two phases differing in microhardness, the Cr_2Nb compound with 1200 to 1850 kg/mm^2 and ternary α solid solution with 250 to 700 kg/mm^2. (R.V.J.)

11681 CONSTITUTION DIAGRAM OF TITANIUM-PALLADIUM ALLOY. A. A. Rudnitskii and N. A. Birun. Zhur. Neorg. Khim. 5: 2414-21(Nov. 1960). (In Russian)

Seventeen alloys of Ti–Pd specimens were studied by methods of thermal and microstructure analysis, hardness, electromotive force, electric resistance, temperature coefficient, and tensile force. The alloy crystallized forming a eutectic at 60 at.% and 1160°C. A chemical compound Pd_2Ti of γ and β solution forms at 1040°C. At room temperature the σ phase of Pd_2Ti is at 20 to 50 at.% titanium. About 20 at.% titanium is dissolved in palladium and 30 at.% palladium in titanium at the eutectic temperature point. Small additions of titanium to palladium reduce the temperature coefficient, increase the specific electric conductivity, and diminish elongation of palladium. The tensile property of palladium is increased two-fold by the small (4%) addition of titanium. The compounds $PdTi_2$, Pd_3Ti_2, or Pd_3Ti formerly reported in the literature were not observed in the experiments. (R.V.J.)

11682 CONSTITUTION DIAGRAM OF TITANIUM–MANGANESE AND MANGANESE–ZIRCONIUM. E. M. Savitskiĭ and Ch. V. Kopetskiĭ (Baikov Inst. of Metallurgy, the Academy of Sciences, U.S.S.R.). Zhur. Neorg. Khim. 5: 2422-34(Nov. 1960). (In Russian)

Physico-chemical reactions of manganese with titanium and zirconium in manganese-rich concentrations were investigated. Microstructure, phase studies, x-ray analysis, and thermal analyses were used, and constitution diagrams were plotted for Mn–Zr and Mn–Ti up to 30 wt.% zirconium and titanium. Intermetallic compounds $ZrMn_2$ and $TiMn_2$ and the isomorphous phase $MgZn_2$ were found with $ZrMn_2$ lattice parameter a = 5.029 kX, c = 8.234 kX, and c/a = 1.637. The lattice parameters of $TiMn_2$ are a = 4.812 kX, c = 7.817 kX, and c/a = 1.624. Compounds such as $TiMn_4$ close to stoichiometric composition formed at 1230°C. Additions of zirconium and titanium do not affect the $\alpha \rightleftharpoons \beta$ transition which takes place at 730°C. The $\beta \rightleftharpoons \gamma$ transition in Mn–Zr alloy follows the peritectoid reaction at 1125°C and in Mn–Ti at 1160°C. The eutectic reaction hardening of Mn–Zr alloys is at 1160°C and in Mn–Ti at 1195°C. The $\gamma \rightleftharpoons \sigma$ transition is at 1225°C following peritectic reaction. The intermetallic compounds $ZrMn_2$, $TiMn_2$, and $TiMn_4$ do not possess the hardness of α and β Mn. (R.V.J.)

11683 PHASE STUDIES OF TUNGSTEN–MOLYBDENUM–RHENIUM ALLOYS. M. A. Tylkina, K. B. Povarova, and E. M. Cavitskiĭ. Zhur. Neorg. Khim. 5: 2458-61(Nov. 1960). (In Russian)

The constitution diagram was plotted of tungsten and molybdenum solid solutions with up to 50 wt.% (~40 to 45 at.%) rhenium. The alloys with cross sections parallel to W–Mo, with content of 10, 20, 30, 40, and 50% rhenium, were analyzed, and three isothermal cross sections of cast alloys, annealed at 1750°C for 3 hr and at 1000°C for 450 hr were plotted. The solubility of the solid solution at 1000°C extends from the binary tungsten alloy with 32 wt.% rhenium to 46 wt.% rhenium (30.5 at.%). The system forms the σ phase; the binary $\alpha + \sigma$ phase is found between the σ phase and the ternary solid solution. The microstructure of alloys with 40 wt.% rhenium is shown. The alloy with 40 wt.% tungsten, 20 wt.% molybdenum is a single phase ternary solid solution at the threshold of solubility, which transforms to binary two-phase $\alpha + \sigma$ at lowered temperature. The ternary solid solutions of W–Mo–Re have excellent mechanical properties, strength, plasticity, and a high melting point. (R.V.J.)

11684 EQUILIBRIUM IN SOLUTION OF URANYL CARBONATE COMPLEXES. A. K. Babko and V. S. Kodenskaya. Zhur. Neorg. Khim. 5: 2568-74(Nov. 1960). (In Russian)

The equilibrium between the hydroxide precipitation of uranyl ion and its carbonate complex in solutions and the optimum values of pH in soluble complex formation were experimentally determined. The equilibrium products of uranyl ion and the instability constant for uranyl carbonate complexes are established. It is shown that under ordinary conditions the solid uranyl carbonate is unstable and undergoes complete hydrolysis. Calculations and experimental data on $UO_2(OH)_2$ solubility in sodium carbonate solution as a function of pH are presented. (R.V.J.)

11685 ON POLYMORPHOUS TRANSFORMATIONS OF CHROMIUM ALLOYED WITH TANTALUM. A. T. Grigor'ev, E. M. Sokolovskaya, M. V. Maksimova, I. G. Sokolova, and N. A. Nedumov (Moscow State Univ.). Zhur. Neorg. Khim. 5: 2640-2(Nov. 1960). (In Russian)

Thermal, microscopic, microhardness, and x-ray-diffraction analyses were made and the constitution diagram was plotted for Cr–Ta alloys with 12.0 wt.% tantalum. Five solid solution regions, α, β, γ, σ, and ϵ, formed by chromium modifications and four two-phase regions, $\alpha + \beta$, $\beta + \gamma$, $\gamma + \sigma$, and $\sigma + \epsilon$, formed at the point of chromium inter-transitions at 1830°C ($\epsilon \rightleftharpoons \sigma$), 1650°C($\sigma \rightleftharpoons \gamma$), ~ 1300°C($\gamma + \beta$), and ~ 930°C($\beta \rightleftharpoons \alpha$). Four eutectoid transformations were observed at 1490, 1150, 950, and 775°C resulting from the eutectoid disintegration of the corresponding solutions. (R.V.J.)

11686 CONSTITUTION DIAGRAM OF CHROMIUM–COBALT ALLOY RICH WITH CHROMIUM. A. T. Grigor'ev, E. Yü P'u (Moscow State Univ.). Zhur. Neorg. Khim. 5: 2642-4(Nov. 1960). (In Russian)

A constitution diagram was plotted for chromium–cobalt alloy rich in chromium (72.6 to 92.0 at.% Cr). The appearance of five chromium modifications was confirmed, and it was shown that in contrast to other diagrams the chromium-base β phase does not suffer eutectoid disintegration but remains unaltered at low temperature. (R.V.J.)

11687 THE NATURE AND THE TEMPERATURE DEPENDENCE OF INTERPLANAR BONDS IN GRAPHITE. V. V. Digonskiĭ and V. N. Krylov. Zhur. Priklad. Khim., 33: 2638-43(Dec. 1960). (In Russian)

The graphitic structure was identified previously (Zhur. Prikl. Khim. 33(No.3): 720(1960)) as behaving like a polyvalent radical which may associate with other lattice units, establishing chemical bonds at the expense of the unsaturation of valencies of neighboring carbon atoms. This was further investigated using a synthetic graphite with an electrical resistance of $\rho = 9.3 \cdot 10^{-4}$ Ω. It was found that under normal conditions a weak covalent bond prevails between the carbon atoms and the adjacent lattice units. The crystallographic model of graphite must be adjusted in such a way as to assign a valency of 4 to the carbon atoms within the graphitic structure. By increasing the temperature from 25 to 700°C, the parameter c of the unit cell increases

from 6.71 to 6.91 A. This temperature function passes through an inflection point at 500°C, thus following the same pattern as the temperature dependence of the linear dimensional changes. The mechanical strength increases with increasing temperature, which also results in the breakage of the chemical bonds, releasing the valence electrons and increasing the electrical conductivity. (TTT)

11688 SPECIFIC SURFACE OF TITANIUM SPONGE. L. V. Biryukova, L. L. Neroslavskaya, and E. V. Mekhova. Zhur. Priklad. Khim., 33: 2791-3(Dec. 1960). (In Russian)

At both high and low temperature titanium interacts with its surrounding medium including O_2, H_2, H_2O, salts, and other materials which are adsorbed on its surface. The amount of impurity present in the finished product is thus strongly dependent on its specific surface. For measurement, the sponge was divided in fractions according to the particle size of the component dendritic crystals. The specific surface was determined by passing rarefied gases through the compacted material. For the determination of the coarse fraction an indirect method was used based on the dissolution rate of the material in 10% HCl. The coarse fraction had specific surfaces ranging from 0.1 to 0.2 m^2/g, while the corresponding values for the fine fraction was 5 to 6 m^2/g. Results of measurements on various fractions of titanium sponge, prepared by several thermic and electrolytic methods, are given. Increasing the large particle fraction during preparation of the sponge resulted in a higher yield of the high-quality metal. (TTT)

11689 RATE OF GROWTH OF CREVICES IN THE PLASTIC RUPTURE OF METALS. V. F. Lozovskaya, P. O. Pashkov, and A. V. Serebryakov. Zhur. Priklad. Mekh. i Tekh. Fiz., No. 1, 103-9(May-June 1960). (In Russian)

The rupture of metals is characterized by successive processes, starting with the formation of initial nuclei of incipient cracks, followed by their coalescence into microscopic crevices that continue into cracks, and leading ultimately to the actual breaking up of the material in separate parts. As brittle fracture is always accompanied by macroscopically observable plastic deformation, the study of the behavior of these deformations in the region of the crack presents a useful tool for predicting cracking of the metal. The growth rate of crevices, together with the breaking load, defines the ultimate probability of cracking. The velocity of propagation of brittle cracks may theoretically reach the speed of sound in that material. However, study of the growth rate of microcrevices accompanied by plastic deformation is complicated by simultaneous rupture phenomena directly caused by plastic deformation. Experimental data showed that the rate of growth depends on the shape and the branching of the crevice; it is the determining parameter in estimating the energy absorbed by the cracking process. (TTT)

11690 PHASES FORMED IN THE BORON-RICH REGION OF THE CHROMIUM–BORON SYSTEM. V. A. Epel'baum, N. G. Sevast'yanov, M. A. Gurevich, and G. S. Zhdanov (Karpov Physico-Chemical Scientific Research Inst.). Zhur. Strukt. Khim., 1: No. 1, 64-5(May-June 1960). (In Russian)

During the investigation of mixtures, the composition of which ranged from CrB_5 to CrB_{24}, the presence of a previously unknown phase, CrB_8, was established in the Cr–B system. The parameters of the tetragonal crystal are a = 5.458 ± 0.001 kX; c = 7.138 ± 0.001 kX; Z = $4CrB_8$; and the density = 3.63 g/cm^3. Pure boron prepared by the thermal decomposition of diborane, and electrolytic chromium were pressed at 500 kg/cm^2; the phase studies were carried out at temperatures reaching up to 1900 to 2200°C. At the upper ranges, the new phase was found to decompose with formation of CrB_2 and crystalline pure boron. (TTT)

11691 CRYSTAL STRUCTURE OF TERNARY PHASES IN THE Mo(W)–Fe(Co,Ni)–Si SYSTEMS. E. I. Gladyshevskii and Yu. B. Kuz'ma (Lvov State Univ.). Zhur. Strukt. Khim., 1: No. 1, 66-71(May-June 1960). (In Russian)

The systems Mo–Fe–Si, Mo–Co–Si, Mo–Ni–Si, W–Fe–Si, W–Co–Si, and W–Ni–Si were investigated in the region up to 33.3 at.% silicon for the purpose of establishing the presence of, and determining the properties of ternary compounds. The following phases were found: MoFeSi, MoCoSi, MoNiSi, WFeSi, WCoSi, and WNiSi. The mixtures were prepared by pressing together the pure metal powders and subjecting them to preliminary heating under argon. They were then heated in vacuum in closed quartz ampoules to 1100°C for 48 hr, then soaked at 800 to 1000°C for 150 hr and quenched several times in cold water after repeated heatings. On the basis of x-ray diffraction studies with a Debye-Preston camera, it was found that the ternary compounds are of the $MgZn_2$ type. In the systems containing cobalt and nickel, the phases consist of pure compounds while the iron-based materials were either ternary compounds or solid solutions based on the binaries $MoFe_2$ and WFe_2. The interatomic distances of the new compounds are listed. (TTT)

11692 PLUTONIUM ALLOYS. (to U. S. Atomic Energy Commission). British Patent 860,161. Feb. 1, 1961.

An alloy containing chiefly plutonium with a minor portion of iron, cobalt, and/or nickel was developed to provide a low melting-point plutonium-metal fuel system for a neutronic reactor in which the fuel container is a metal not affected by the constituents of the fuel. The iron, cobalt, and/or nickel is present in the proportion of from 8 to 15 at.%. The plutonium used in these alloys is at least 98 to 99% pure. The alloys were prepared in a magnesium oxide crucible in a vacuum furnace at temperatures between 1000 and 1200°C. (M.C.G.)

11693 URANIUM BEARING STEEL. William A. Morgan, Roger D. McDonald, and Gustad P. Contractor (to Minister of Mines and Technical Surveys). Canadian Patent 609,013. Nov. 22, 1960.

A steel of high fatigue strength, high-temperature creep-rupture properties, and high stress-corrosion resistance may be obtained by adding to a carbon or ferritic alloy steel 0.01 to 1.0% uranium, preferably 0.01 to 0.03%. The mechanical properties and test results of steels with and without uranium are tabulated for comparison. (D.L.C.)

Radiation Effects

11694 (AD-240718) IRRADIATION OF PHENOLIC AND EPOXY RESIN MODEL COMPOUNDS. Quarterly Progress Report No. 1—April 1 - June 30, 1960. Dale E. Van Sickle (Stanford Research Inst., Menlo Park, Calif.). July 11, 1960. 9p. SRI Project No. SU-3204. Contract DA-04-200-ORD-1056, Project TB4-721.

Activities in a program to determine the mechanism of radiative degeneration of phenol-formaldehyde resins are reported. Seven irradiations with a 1-Mev electron source were made on saligenin, 2,2'-dihydroxydiphenylmethane, 4-4'dihydroxydiphenylmethane, and 2,4'-dihydroxydiphenylmethane. Resulting data are tabulated. (J.R.D.)

11695 (AERE-R-3537) IRRADIATION EXPERIMENTS WITH AQUEOUS SUSPENSIONS OF PLUTONIUM DIOXIDE. B. R. Harder and R. G. Sowden (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy

Research Establishment, Harwell, Berks, England). March 1960. 22p.

The effects of exposing dilute aqueous plutonia suspensions to pile irradiation were investigated. Solids of high specific surface area (~30 m^2/g) undergo rapid fragmentation; colloidal suspensions are formed which are stable indefinitely at room temperature but which flocculate slowly at 200°C. The degree of fragmentation per unit of dose decreases with the specific surface area of the suspended plutonia, but the effect was still measurable with high-fired material (<0.3 m^2/g). Fragmentation may occur exclusively along crystallite boundaries or extend to comminution of the crystallites themselves. Measurements were made of the distribution of selected fission products between the plutonia surface and the aqueous phase after short irradiations at reactor temperature. Barium was retained exclusively in the aqueous phase under all conditions by which molybdenum, zirconium, and iodine were predominantly adsorbed by the solid surface. The distribution of cerium and tellurium is sensitive to the pH of the suspension. Cerium was entirely adsorbed on the surface after irradiation at pH 6, but after irradiation at a pH of <2 it was found exclusively in the aqueous phase. The implications of these findings on the feasibility of continuous fission-product removal in a suspension reactor are discussed. (auth)

11696 (AFOSR-TR-60-160) RADIATION EFFECTS INVOLVING THE (n,α) REACTION IN GLASS CONTAINING BORON. Rohn Truell and Constantine Mylonas (Brown Univ., Providence. Metals Research Lab.). Oct. 1, 1960. Contract AF49(638)-450. 35p.

The damage effects produced in 7070 glass by means of the slow neutron reactions with B^{10} were examined by measurement of physical dimensions, photoelastic measurements, and ultrasonic methods. The measurement of sample lengths as a function of irradiation time or flux shows that although there are large changes in dimensions as the result of annealing, the irradiation changes are apparently independent of the annealing changes. The curve of length contraction as a function of irradiation flux is not linear. Photoelastic determination of optical-stress characteristics was carried out with higher precision than previously. Ultrasonic attenuation and velocity measurements are valuable in annealing experiments but they are not at present useful for in-reactor study of damage with this material. (auth)

11697 (CEA-1443) CONTRIBUTION A L'ÉTUDE THÉORIQUE ET EXPÉRIMENTALE DE L'EFFET ÉLECTRON-VOLTAIQUE DANS LES JONCTIONS-N. P. (Contribution to the Theoretical and Experimental Study of the Electron-volt Effect in the N-P Junctions). Nguyen-Van-Dong (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 88p.

Thesis submitted to Univ. of Paris.

The proposed aim of this work was to study the behavior of a semiconducting junction under the action of β radiation. These studies were directed on the one hand to direct conversion of the energy radiated by a radioactive source of electric energy utilizable by means of n-p junctions and on the other hand to the kinetics of defects produced in the semi-conductor crystals by high-energy β rays. In the first part of this work, an attempt was made to complete the earlier theories of the electron-volt effect in junctions by analyzing the effect mathematically. This led to a single equation containing the electrical and geometric parameters of the semiconductor and of the junction and the properties of the incident radiation. Apart from this, the diffusion current of the charge carriers created by the bombardment was studied in more detail, taking into account all the factors that play a part in the expression of the efficiency of charge collection of a junction. In the second part, where experiments on the irradiation of n-p junctions were carried out with a Sr^{90}-Y^{90} source, mention is made of the particular advantages of a gallium arsenide junction capable of operating at relatively high temperatures (in the region of 100°C). The third part presents the study of defects created in a semiconductor crystal by high-energy β rays, according to the method of electron-volt effect. It is shown that from a study of the degradation of the short-circuit current of the junction it may be possible to determine the recombination level and the probabilities of electron and hole capture, as from a study of the lifetime decay of minority carriers in a crystal of known type. Experiments on the bombardment of Ge junctions by 2-Mev electrons were performed with a Van de Graaff. Very clear anomalies of the electron-volt effect at 100°K were observed. An attempt was made at interpretation of these anomalies in the junction, taking into account other phenomena which occur at low temperature. In the fourth part, results concerning the healing of the defects and protection measures against too energetic β rays are described. A healing difference was observed between the lifetime and the conductivity. Finally, interesting results were obtained from experiments using a cadmium sulfide film to transform the β particles of Sr^{90}-Y^{90} into photons. (auth)

11698 (CRDC-1001) A COMPARISON OF METHODS OF DETERMINING BURNUP ON URANIUM DIOXIDE FUEL TEST SPECIMENS. PART 1. STUDIES ON A SINGLE STRINGER FUEL CHARGE. R. G. Hart, M. Lounsbury, and C. D. McKay (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1961. 25p. (AECL-1176)

A study of methods of determining burn-up in fuel test specimens was made to determine the confidence that can be placed in the burn-up numbers so obtained. The methods compared include U^{235} depletion, cobalt monitoring, Cs^{137} production, plutonium production, calorimetry, and calculation from reactor power and standard flux maps. A comparison of data obtained on portions of the specimen with that obtained on the complete specimen was also included. It was found that all of the methods agree to within their analytical accuracy (~± 3%) with the exception of the Cs^{137} method which gives results that are on the average ~15% low. The limitations and pitfalls of all of the methods are discussed in some detail. It was also found that a complete cross-section of the test specimen, approximately ½ in. long, is the minimum sample required to give representative burn-up data. The integration from this to the complete specimen is relatively straightforward. Any sample not comprising a complete cross-section involves radial as well as logitudinal integration giving results that are relatively uncertain, particularly in samples of high heat rating where migration of many species is a distinct possibility. (auth)

11699 (CRFD-964) THE IRRADIATION OF SINTERED UO_2 IN 0.1 mm STAINLESS STEEL SHEATHS. R. D. MacDonald and A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1960. 36p. (AECL-1159)

Three uranium oxide specimens sheathed in 0.1-mm stainless steel were prepared for inclusion in the X-2-U test. Two of these specimens failed. The failure of specimen SB is suggested to be due to an inclusion in the air-melted stainless steel. The failure of specimen SD was attributed to the fabrication procedure which resulted in ridges running longitudinally along the sheath. Specimen

SC, which remained intact throughout the test, showed no diametral increase after the first irradiation cycle but had a measurable increase after the second cycle. The other two specimens showed an increase after their first irradiation. The cracking pattern reproduced on the inner surface of the sheath made possible a measurement of the size of UO_2 fragments, and proved that the pellets did not move axially within the sheath. The uranium oxide displayed only radial cracking. Circumferential cracks, usually associated with UO_2 irradiated at sufficient heat rating to produce grain growth, were not observed. (auth)

11700 (DEG-Report-268) THE MEASUREMENT OF THE RATE OF RELEASE OF STORED ENERGY IN GRAPHITE WITH THE DIFFERENTIAL THERMAL ANALYSIS EQUIPMENT. D. M. Evans and L. Brown (United Kingdom Atomic Energy Authority. Development and Engineering Group, Windscale, Cumb., England). Oct. 5, 1960. 18p.

Modifications to the original form of the differential thermal analysis equipment have eliminated the main sources of random errors; the revised method does not require a reference sample. A change in design of the copper block has greatly simplified the assembly and reduced the magnitude of temperature gradients in the block. An experimental correction is shown to be adequate for both thermocouple differences and the remaining temperature gradients. Some values obtained for the rate of release of stored energy indicate that the equipment in its present form is capable of giving results which are in fair agreement with those obtained on similar samples by other methods. (auth)

11701 (DP-210) IRRADIATION OF POWDER METALLURGY PLATES. George R. Caskey, Jr., C. L. Angerman, D. L. Douglass, and R. P. Marshall (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.) April 1957. 16p. Contract AT(07-2)-1.

Four plates of uranium, fabricated by powder-metallurgy techniques and clad with 1100 aluminum by hot pressing, were irradiated in the Materials Testing Reactor. Increases of about 0.5% in length and 1% in thickness were observed after exposure of 1600 Mwd/T. The surfaces of the plates remained smooth. (auth)

11702 (DP-211) IRRADIATION OF WROUGHT URANIUM PLATE. William R. McDonell and Robert P. Marshall (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1957. Decl. Oct. 12, 1960. 36p. Contract AT(07-2)-1.

Wrought uranium plate, clad in 1100 aluminum with a nickel bonding layer, was irradiated to a maximum exposure of 1600 Mwd/T in the Materials Testing Reactor and was found to be suitable as a fuel-element material. Beta-transformed plate, or beta-transformed plate that was cold stretched 2.25%, did not change appreciably in dimensions but roughened on the surface. As-rolled plate increased in length, but did not roughen. Irradiation reduced the strength and virtually eliminated the ductility of the plate. Abrasion of the cladding caused corrosion pitting. The strength of the nickel diffusion bond between core and cladding was unimpaired by the irradiation. (auth)

11703 (DP-534) MECHANICAL PROPERTIES OF IRRADIATED WELDS IN STAINLESS STEEL. J. Walter Joseph, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1960. Contract AT(07-2)-1. 12p.

Neutron irradiation at a temperature below 100°C increased the strength and hardness and decreased the ductility of specimens that had been machined from welded stainless-steel plate. Welds in type 304 stainless steel had a higher yield strength and lower ductility than the parent plate, both before and after exposure to 1.2×10^{21} fast neutrons/cm 2. The ultimate strengths of weld metal, heat-affected zone, and parent plate were approximately equal, both before and after irradiation. (auth)

11704 (HW-65999) EXAMINATION OF AN IRRADIATED, ZIRCALOY-2, HOT WATER LOOP TUBE. A. L. Bement (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 8, 1960. 18p.

A test program was conducted on Zircaloy-2 hot-water loop tubes to obtain information about changes in properties caused by the operating conditions and irradiation, and to determine which tests and methods would be useful for routine tube monitoring. Exposure of the 70% cold-worked tubing to water at 175 to 235°C did not result in significant corrosion over the operational life of the tube. Metallographic examinations indicate that the hydrogen content of both irradiated and unirradiated tubes did not increase significantly during service. Tensile tests revealed that radiation hardening and cold-work recovery occurred in the in-reactor tubes. Mechanical property measurements at room temperature gave: tensile strength—78,600 to 111,000 psi; yield strength—50,400 to 100,300 psi; and total elongation—2.0 to 10.9%. The normal effects of radiation hardening on strength and ductility were observed in 300°C tensile tests. The maximum tensile strength was 66,000 psi, and little or no change was noted in the total elongation. Partial recrystallization in the irradiated tubing, revealed by metallographic examination, was attributed to localized heat transfer from the graphite support block to the tube. Techniques were developed which simplify the preparation of tensile specimens from irradiated tubing and provide a practical and ready means for measuring the mechanical properties of discharge tubes. (B.O.G.)

11705 (IDO-16628) ETR RADIATION DAMAGE SURVEILLANCE PROGRAMS. PROGRESS REPORT I. M. J. Graber and J. H. Ronsick (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 27, 1961. Contract AT(10-1)-205. 29p.

Data showing the change in mechanical properties of materials exposed to the neutron environment of the Engineering Test Reactor core are presented. The materials selected for testing, 2024, 6061, and 356 aluminum; Inconel X (single and double aged); Inconel 702; 17-4 PH, 304, 347, and AM-350 stainless steels; and Zircaloy-2, are those used for construction of reactor components and test facilities. The maximum radiation dosages received by the various materials ranged between 1.17×10^{20} nvt (>1 Mev) for 6061 aluminum and 5.72×10^{21} nvt (>1 Mev) for 304 stainless steel. (auth)

11706 (NAA-SR-5970) ZIRCONIUM MODERATOR CLADDING IRRADIATED IN THE SODIUM REACTOR EXPERIMENT. J. J. Gill (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 15, 1960. 35p. Contract AT-11-1-GEN-8.

Visual examinations, chemical analyses, bend tests, and metallographic examinations were performed on specimens of SRE zirconium cladding material to determine the effects of approximately 4500 hr of reactor operation. Based on the results of this investigation, the SRE zirconium remaining in the core is deemed satisfactory for continued reactor operation under design conditions. During reactor exposure, the general appearance of the zirconium cladding surfaces exposed to the sodium was unchanged. Several cans ruptured as a result of a swelling of the graphite caused by the entry of sodium into the cans. No grain growth occurred at the normal maximum reactor operating temperature of about

950°F. Increases in the hydrogen content, to as much as 1000 ppm, during SRE exposure caused no change in the ductility of the zirconium at normal reactor operating temperature, even though it was very brittle at room temperature. (auth)

11707 (NASA-TN-D-683) THERMOLUMINESCENCE OF SODIUM CHLORIDE IRRADIATED WITH 40-MEV ALPHA PARTICLES. Charles C. Giamati, Michael Hacskaylo, and Gabriel Allen (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Mar. 1961. 13p.

The effect of 40-Mev α particles on sodium chloride crystals was investigated by means of postirradiated thermoluminescence measurements. A possible mechanism is suggested to account for the results. The suggested interpretation of the results allows a partial separation to be made of the effects of atomic displacement from the effects of ionization. The explanation appears to be consistent with diverse other investigations of alkali halides. (auth)

11708 (NP-9728) LIST OF REIC PUBLICATIONS ISSUED. MONTHLY ACCESSION LIST 42 [ON RADIATION EFFECTS DATA]. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Dec. 15, 1960. 26p., Contract AF33(616)-7375 [Continuation of AF33(616)-6564], Task No. 13008, Project No. 4458.

11709 (NP-9735) A STUDY OF RADIATION EFFECTS ON ELECTRONIC DEVICES. Second Interim Report (Part II): December 1, 1959 to June 30, 1960. Harold S. Sauer (Edgerton, Germeshausen and Brier, Inc., Boston). July 31, 1960. 122p. Contract DA-36-039 SC 78171, Project No. 3-19-01-701.

At the KEWB reactor of Atomics International, transient and long-term measurements were made on a group of transistors and tubes. This experiment was the last of three radiation-effects experiments conducted at three pulsed nuclear reactors (Godiva II, TRIGA, and KEWB). The data obtained at KEWB corroborated the data previously obtained at Godiva II and TRIGA. The I_{co} and H_{FE} parameters of the transistors were affected by the dose rate and the integrated dose of the radiation pulse. Shifts in the operating point of the triodes, probably caused by radiation-induced grid currents, temporarily changed the gain of the tubes. Operation of the thyratrons was disturbed during the pulse. Except for some discoloration of the glass envelopes of the triodes and thyratrons, no permanent tube damage was found. (auth)

11710 (NP-9799) MONTHLY ACCESSION LIST NO. 43 [ON RADIATION EFFECTS DATA]. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Jan. 15, 1961. 34p. Project No. 4458. Contract AF33(616)-7375.

11711 (NP-9805) IRRADIATION DAMAGE IN ION EXCHANGE MATERIALS. K. A. Nater (Joint Establishment for Nuclear Energy Research, Kjeller, Norway). 1959. 135p. (JENER Pub. 17)

Radiation damage in several organic and inorganic ion-exchange materials was investigated, and mechanisms for the reactions are offered. The exchange capacity and water swelling of Imac C-12, Amberlite 401, Stamex-S, Dusarit-S, Permutit-G, and MnO_2 were measured before and after irradiation by Co^{60}, reactor radiation (JEEP), and 1-Mev electrons from a cascade generator. No noticeable damage was induced in the inorganics (the latter two), the Co^{60} source was too weak to affect the organics, and the reactor and electron irradiation of organics gave about equal results. The sulfonated polystyrenes lost 20% of capacity after 1 gigarad, whereas the quaternary amine polystyrenes lost 50%. The skeleton of the former degrades; the latter cross-links. The damage is independent of dose rate up to 1 mrad/sec. It was concluded that meta functional groups in the benzene nucleus are less stable than ortho or para. Calculations showed that atomic displacement played a minor role compared to electron activation. Aromatics are more radiation-stable than aliphatics. Estimates of ion-exchanger life are given, and applications of ion exchangers in nuclear engineering are discussed. (T.R.H.)

11712 (NP-9814) FOKUSSIERENDE 110-STOSSFOLGEN IN FLÄCHENZENTRIERTEN KRISTALLEN BEI KLEINEN WINKELN. (Focusing Collision Along 110-Lanes in Face-Centered Crystals for Small Angles). Chr. Lehmann and G. Leibfried (Aachen. Technische Hoghschule and Kernforschungsanlage. Institut für Reaktorwerkstoffe, Jülich, Germany). 1960. 26p.

A study was made of focused collisions along close-packed 110-directions in face-centered lattices. If only small angles and focused collisions are considered the energy is practically completely transferred, and the energy changes along the chain can be neglected. This corresponds to the billiard-ball model. The focusing parameter is thus a function of the collision energy. The variation from the hard sphere approximation is discussed and quantitatively calculated. The effects of neighboring lines are neglected. The results are compared with those of Vineyard et al., J. Appl. Phys., 30: 1322 (1959). (T.R.H.)

11713 (NP-9821) IRRADIATION OF PHENOLIC AND EPOXY RESIN MODEL COMPOUNDS. Quarterly Progress Report No. III, October 1, 1960–January 1, 1961. Report No. 9. Dale E. Van Sickle (Stanford Research Inst., Menlo Park, Calif.). Jan. 5, 1961. 12p. SRI Project No. SU-3204. Contract DA-94-200-ORS-1056.

Electron irradiation of certain phenol-formaldehyde model compounds is being conducted to gain insight of the degradative process on the thermosetting resins, which are potentially useful as materials of construction for outer space vehicles. The break-down process during irradiation of the model compounds was studied by conducting experiments with 2,2′-dihydroxydiphenylmethane (DDM), its dimethyl ether, and some radical traps. Two experiments were done by irradiating a mixture of 2,2′-DDM and iodine; an irradiation of 2,2′-DDM was also done under an oxygen atmosphere; and one run was made on the dimethyl ether of 2,2′-DDM. The results are summarized tabularly. The Co^{60} irradiation of ortho-para linear phenol-formaldehyde polymer was repeated and the results, along with those from previous work on the ortho-ortho isomer, are reported. (auth)

11714 (ORNL-3050) EXPERIMENT ON CONTINUOUS RELEASE OF FISSION GAS DURING IRRADIATION. (An Interim Report). R. M. Carroll and C. D. Baumann (Oak Ridge National Lab., Tenn.). Feb. 23, 1961. Contract W-7405-eng-26. 28p.

A facility was constructed in which fuel materials may be irradiated to determine their ability to retain gaseous fission products during irradiation. The fuel is heated by its own fission power, which is adjusted by moving the fuel into and out of the reactor neutron flux. At constant power the temperature of the fuel is regulated by air cooling. Fission gas from the fuel is entrained in an inert-gas sweep and carried outside the reactor for analysis. The neutron flux at the fuel may be determined by argon activation. Two samples of ceramic fuel, ThO_2–UO_2 and UO_2, were irradiated in the facility. The total activity of the released

fission gas from both samples was dominated by short-lived isotopes. Measurements from 1000 to 2000°F show that iodine, xenon, and krypton were released by a temperature-dependent process above 1300°F. Diffusion coefficients were calculated for the UO_2 sample. There was no change in thermal conductivity of 95% density UO_2 to 2300 Mwd/metric ton burn-up; at 1000 to 2000°F, $K = K_0 e^{-1.21T \times 10^{-3}}$ (T = °K). An in-pile oxidation of UO_2 was indicated by a stored-energy release and a large increase of fission-gas release. A 3% hydrogen addition to the sweep gas partially reduced the fuel and decreased fission-gas release. (auth)

11715 (REM-899) RADIATION EFFECTS MANUAL. RUBBER AND RUBBER PRODUCTS. P. M. Johnson (Convair, Fort Worth, Tex.). Oct. 26, 1959. 550p.

Data are presented on radiation effects to natural and synthetic rubber and rubber products found in aircraft. The rubber products covered include aircraft tires and tire materials, gaskets, O-rings, packings, and hoses and hose materials. All available information on samples, test methods, and irradiation conditions is recorded. (W.L.H.)

11716 (SRB-60-4) RADIATION EFFECTS ON ELECTRONIC CIRCUITS. A. A. Beltran, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Aug. 31, 1960. 47p.

A bibliography on radiation effects on electronic circuits is presented. Reports and articles on designing for radiation environments, shielding, reliability, test procedures, and results are included. 73 references. (J.R.D.)

11717 (TID-5804) EFFECT OF STRAIN RATE ON TENSILE STRENGTH OF IRRADIATED AND NON-IRRADIATED DRAWN AND UNDRAWN NYLON. Technical Report No. 5. Y. C. Das and C. C. Hsiao (Minnesota. Univ., Minneapolis). July 1959. 15p. Contract AT(11-1)-532.

Simple tension stress-strain properties for irradiated and nonirradiated drawn and undrawn nylon samples were experimentally determined for several different rates of straining. Within the range of strain rate studied, the tensile strength was found to be linearly related with the logarithm of strain rate. (auth)

11718 (USASRDL-TR-2123) THE USE OF PLASTIC SHIELDS TO REDUCE PERMANENT NUCLEAR RADIATION DAMAGE. Edwin T. Hunter (Army Signal Research and Development Lab., Fort Monmouth, N. J.). June 15, 1960. 15p. (AD-239157)

Permanent alterations in d-c electrical characteristics of germanium homogeneous-base pnp power transistors was determined as a function of the thickness of epoxy type shielding material surrounding the device. Exposures were made on the Godiva reactor. Results indicate that most of the permanent damage is caused by fast neutrons, with a smaller part of the damage being caused by some other component of the radiation, and that the epoxy shields thermalize many of the fast neutrons, thereby reducing the permanent damage suffered by the transistors. The subsequent increase in thermal neutrons and γ rays inside the shields will probably have an effect on the transient alterations in electrical characteristics of the devices, but this facet of the investigation was not studied. (auth)

11719 (WAPD-TM-262) DIMENSIONAL INSPECTION OF IRRADIATED PWR CORE 1 BLANKET FUEL. L. D. Larson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1960. Contract AT-11-1-GEN-14. 20p.

A dimensional inspection of partially expended PWR-1 fuel components was completed. The components investigated were removed from service at the end of the first seed life. A comparison of preirradiation and postirradiation measurements indicates that no significant dimensional changes resulted from operation through the first seed life. The investigation verified the adequacy of design assumptions and preirradiation testing with respect to dimensional stability. It provides a basis for predicting the continued serviceability of blanket fuel from the standpoint of dimensional stability. (auth)

11720 (AERE-Trans-858) CHANGES IN THE PROPERTIES OF MATERIALS DUE TO IRRADIATION WITH PARTICLES AND PHOTONS. K. Sagel. Translated by R. Hardbottle from Metall, 12: 353-62(1958). 27p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 13030.

11721 (NP-tr-521) THE ELECTROPHYSICAL PROPERTIES OF TECHNICAL ELECTRICALLY INSULATING MATERIALS UNDER CONDITIONS OF RADIOACTIVE IRRADIATION. K. A. Vodop'yanov, B. I. Vorozhtsov, G. I. Potakhova, and N. I. Ol'shanskaya (Tomsk State Univ., U.S.S.R.). Translated by A. N. Dellis from Elektrichestvo, No. 5, 60-6(1960).

This paper was previously abstracted from the original language and appers in NSA, Vol. 14, as abstract No. 15134.

11722 A DEVICE FOR EXAMINING THE EFFECTS OF GAMMA RAYS ON SEMICONDUCTORS. B. M. Konovalenko, S. M. Ryvkin, I. D. Yaroshetskiĭ, and L. P. Bogomazov. Atomanya Energ. 9: 408-9(Nov. 1960). (In Russian)

An installation for examining the effects of γ rays on the electric conductivity of semiconductors is described. The device is capable of establishing parameter defects in various semiconductors. The dosage of specimens at various distances in the chamber is tabulated, and the results confirmed the efficiency of the device. (R.V.J.)

11723 WHAT DESIGNERS SHOULD KNOW ABOUT TRANSIENT RADIATION. John W. Clark, Thomas D. Hanscome, and Herbert L. Wiser (Hughes Aircraft Co., Los Angeles). Electronics, 34: No. 6, 62-5(Feb. 10, 1961).

Transient effects of radiation leading to circuit malfunction are treated in detail. These effects, arising from ions or electron-hole pairs created by penetrating γ's or neutrons of energy >1 Mev, produce additional shunt resistors and transient currents. The effect of 8-μsec γ pulses on the output of a low-level amplifier is illustrated. The difference between transient and dose effects of radiation is discussed. A tentative procedure for designing radiation-resistant systems is given which includes use of low-impedance designs and testing. The problem of nuclear weapon simulation is considered. The following pieces of equipment are suitable for such simulation: a γ linac operating at an electron energy of 10 Mev, a bare critical assembly such as Godiva, and a 30-Mev linac using the photofission process to produce neutrons. (D.L.C.)

11724 SOME RECENT DEVELOPMENTS IN THE THEORY OF RADIATION DAMAGE. G. H. Vineyard (Brookhaven National Lab., Upton, N. Y.). Energia nucleare (Milan), 8: 9-15(Jan. 1961). (In English)

The status of knowledge of radiation-damage mechanisms in crystals is pointed out, and computer studies at BNL are summarized. (T.R.H.)

11725 INFLUENCE OF DEFECTS CREATED BY NEUTRON IRRADIATION ON RECOMBINATION PROCESS IN GERMANIUM. R. F. Konopleva, T. V. Mashovets, and S. M. Ryvkin (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Fiz. Tverdogo Tela, Akad. Nauk S.S.S.R., Sbornik Statei, 2: 11-21(1959). (In Russian)

The influence of 14-Mev neutron bombardment on the

life time of current carriers in n type germanium was analyzed. It is shown that the energy of the activated levels responsible for recombination in the specimen, determined by the life time curve plotted as the function of temperature, is 0.20 ev. The mean hole-capture cross section for q_p levels was 1.6×10^{-15} cm. The dependence of radiation defect concentrations on annealing time is not exponential in character. The annealing process is well interpreted by the theory describing recombination limited by diffusion. (R.V.J.)

11726 REGENERATION OF MECHANICAL PROPERTIES OF IRRADIATED ROCK SALT AFTER ANNEALING. B. V. Budylin and A. A. Vorob'ev. Fiz. Tverdogo Tela, Akad. Nauk S.S.S.R., Sbornik Statei, 2: 242-3(1959). (In Russian)

Regeneration of plastic properties, microhardness, elasticity, and strength was observed in irradiated (reactor) rock salt following annealing at 400°C. Data on mechanical changes in irradiated rock salt are plotted as a function of annealing temperature. (tr-auth)

11727 EFFECT OF PILE IRRADIATION ON THE DIELECTRIC PROPERTIES OF TRIGLYCINE SULFATE SINGLE CRYSTALS. Ennio Fatuzzo (RCA Ltd., Zurich Switzerland). Helv. Phys. Acta 33, 501-4(1960). (In English)

Plates of triglycine sulfate, cleaved perpendicular to the ferroelectric direction and ground to a thickness of 0.2 mm, were exposed to pile radiation. The hysteresis loops were then studied as a function of irradiation. It was found that irradiation deformed the hysteresis loops very much. When the crystal is irradiated with more than 3×10^{15} nvt, the loop starts deteriorating, becoming less and less square. All ferroelectric properties disappear after irradiation with more than 5×10^{15} nvt. The bias produced by irradiation disappears upon continuous 50-cps cycling of the sample, but it returns if the crystal is allowed to rest. The radioinduced bias is oriented in the same direction as the small original bias. (J.S.R.)

11728 THE ACCUMULATION OF WIGNER ENERGY IN GRAPHITE. Vittorio Betta. Ing. nucleare, 3: 111-17 (May-June 1960). (In Italian)

A short survey is included on the principal alterations produced in graphite by neutron irradiation. On the basis of the experimental data on the accumulation of energy, a plan is outlined for a theoretical interpretation. In so doing, reference is made to the somewhat analogous problem of the accumulation of hardening energy in metals submitted to cold plastic deformation. The treatment corresponds with an approximation to experimental data and to values given by some theories on displacements of atoms in elastic shocks. These latter theories are discussed briefly. An equation is set up whereby, starting from only a few experimental data, it is possible to foresee, with good approximation, the amount of energy accumulated in graphite and, presumably, in other materials for any dose of radiation absorbed under the same thermic conditions. (auth)

11729 ENERGY DEPENDENCE OF RADIATION DAMAGE IN TUNGSTEN. D. R. Muss and J. R. Townsend (Univ. of Pittsburgh). J. Appl. Phys., 32: 189-92(Feb. 1961).

The rate of radiation damage in tungsten is shown experimentally to depend on the energy of the incident deuterons almost as 1/E. The small deviation from the 1/E dependence is in a direction opposite to that predicted by the hard sphere model for secondary defect production. (auth)

11730 HIGH-ENERGY RADIATION DAMAGE TO FLUORESCENT ORGANIC SOLIDS. Charles F. Sharn (Naval Research Lab., Washington, D. C.). J. Chem. Phys., 34: 240-6(Jan. 1961).

Radiation damage to organic solids exposed to Co^{60} γ rays was studied through the analysis of the induced fluorescent changes. From the fluorescence degradation for two series of aromatic hydrocarbons, correlations between chemical structure and radiation damage were established. In addition, modifications in a conventional model used to describe the fluorescent degradation mechanism in organic materials are suggested by the data. Some of the organic materials studied have potential application in a dosimetry system based on fluorescence degradation. (auth)

11731 PARAMAGNETIC RESONANCE STUDY OF IRRADIATED SINGLE CRYSTALS OF CALCIUM TUNGSTATE. Henry Zeldes and Ralph Livingston (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 34: 247-52(Jan. 1961).

Gamma irradiation of calcium tungstate at 77°K produces two paramagnetic species in high yield. Measurements of yields and of rates of disappearance upon warming indicate the two species are formed and disappear upon warming in one to one correspondence. The principal axis directions and g tensors were measured and indicate that one species contains a surplus electron while the other is electron-deficient (hole). Hyperfine effects of W^{183} were observed. The electron-deficient species contains two tungsten atoms with small isotropic hyperfine interactions. Its unpaired electron must be highly localized in orbitals of atoms other than tungsten. The electron-surplus species contains one tungsten atom with an anisotropic hyperfine interaction. This center could be WO_4^{3-}, but from the lack of symmetry of the measured g values it must be formed near a lattice defect. Experiments with heat-treated crystals indicate lattice defects to be important in the radiation effect. (auth)

11732 ELECTRON SPIN RESONANCE IN A GAMMA-IRRADIATED SINGLE CRYSTAL OF L-CYSTINE DIHYDROCHLORIDE. Yukio Kurita and Walter Gordy (Duke Univ., Durham, N. C.). J. Chem. Phys., 34: 282-8(Jan. 1961).

The electron spin resonance of a γ-irradiated single crystal of L-cystine dihydrochloride was measured at 9 and 24 kMc for various orientations of the crystal in the magnetic field. The resonance pattern was found to be a doublet, the spacing between the components of which is independent of the crystal orientation as well as of the strength of the static magnetic field. The spectroscopic splitting factor was found to be anisotropic with the principal values: $g_u = 2.003$, $g_v = 2.025$, and $g_w = 2.053$. A model of the free radical, $COOHCH(NH_2)CH_2S$, in which the electron spin density is mainly concentrated in a nonbonding 3 p orbital of the sulfur atom, is proposed. The model accounts very well for the principal values of the g tensor, as well as their directions relative to the atomic configuration. It also can give rise to the observed proton hyperfine structure. (auth)

11733 THE THERMAL DECOMPOSITION OF IRRADIATED RUBIDIUM PERMANGANATE. P. J. Herley and E. G. Prout (Rhodes Univ., Grahamstown, South Africa). J. Inorg. & Nuclear Chem., 16: 16–22(Nov. 1960). (In English)

The thermal decomposition of $RbMnO_4$, preirradiated in the spent-fuel facility at Harwell and in a hollow uranium slug in BEPO, was investigated in the temperature range 195 to 245°C. The results for γ-irradiated $RbMnO_4$ are similar to those for irradiated $AgMnO_4$ and $KMnO_4$, and the mechanism proposed for the latter is again suggested. The activation energy for the migration of point defects

over the induction period is 1.59 ev. The p-t plots for pile-irradiated $RbMnO_4$ are complex and are explained in terms of a mechanism involving the formation of thermal and/or displacement spikes. (auth)

11734 DISTRIBUTION OF INTERSTITIALS AND VACANCIES PRODUCED BY AN INCIDENT FAST NEUTRON. Masayuki Yoshida (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 44-50(Jan. 1961). (In English)

The distribution of the interstitial-vacancy (I-V) pairs produced in a substance such as germanium by successive knock-on is discussed. Calculation of the distribution is performed, based on the formula proposed by Bohr and Seitz and Koehler, and applying the Monte Carlo method. The ratio of the close I-V pairs to the total I-V pairs produced by an 10^4 ev first knocked-on atom is about 60%. Taking into account the replacement collision, a decrease of about 40% in the total number of the I-V pairs is obtained and the ratio becomes 30%. The decrease in the total number reduces the difference between the total number deduced from calculation and that obtained by experiment. The following results are also obtained. The interstitials and vacancies are distributed in several groups. They exist in the region enveloped by a sphere of from 50 to 100 atomic distances of diameter. There is no tendency that the concentrated damaged region spreads in the incident direction of the first knocked-on atom and that the interstitials distribute in the outer part of the concentrated damaged region. (auth)

11735 RADIATION INDUCED OPTICAL ABSORPTIONS IN CRYSTALLINE QUARTZ AND FUSED SILICA. Kazuko Kubo (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 108-13(Jan. 1961). (In English)

The optical absorption of γ- and fast-neutron-irradiated crystalline quartz and fused silica was measured from 186 mμ to 2.6 μ. Dichroism of the A-band was confirmed. The phenomenon of radiation bleaching of the B_1-band and a remarkable movement of the C-band were found. The irradiation and optical bleaching experiments showed that only the C-band is essential due to radiation, and this was considered to be caused by an absorption center similar to the F-center which changes F'- or colloidal-center with subsequent irradiation. (auth)

11736 CHANGE OF SURFACE STATE OF Ge BY ELECTRON BOMBARDMENT. Kiichi Komatsubara (Hitachi Central Research Lab., Tokyo). J. Phys. Soc. Japan, 16: 125-6(Jan. 1961). (In English)

The effects of electron bombardment on the surface state of germanium were studied by measuring the reverse current of a field in a p-n junction. An alloy type n-p junction was prepared with 30 ohm-cm n type germanium, and the reverse current for an electric field applied to the surface opposite from the alloying surface was photographed on an oscilloscope before and after bombardment of varying electron dosages up to 4.2×10^{15} electrons/cm^2 (0.8 Mev and 0.2 μa). The contribution to the reverse current is the recombination of charged carriers on the germanium surface, and surface potential was computed from the data. The curve showing the relationship between the surface potential and dosage is given. (D.L.C.)

11737 ANNEALING OF RADIATION DAMAGE ON LIFETIME IN SILICON. Kenji Matsuura and Yoshio Inuishi (Osaka Univ.). J. Phys. Soc. Japan, 16: 339(Feb. 1960). (In English)

Annealing effects on carrier lifetime τ in γ-irradiated n type silicon was studied. Samples of 40 ohm-cm antimony-doped pulled silicon and 20 ohm-cm floating-zoned silicon containing little O_2 were irradiated by Co^{60}. The curves of annealing temperature versus $1/\tau - 1/\tau_0$ and isothermal percentage annealing are shown. The pulled silicon annealing curve shows a peak at 200°C, and the percentage annealing curve shows a peak at 240°C which the floating-zoned silicon does not show. The activation energy of the annealing process in floating-zoned silicon is calculated as 1.2 ev. (T.R.H.)

11738 OBSERVATIONS OF DISLOCATION NETWORK IN NEUTRON-IRRADIATED LiF CRYSTAL. Kazuko Kubo and Yoshio Katano (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 347-8(Feb. 1960). (In English)

Phase-contrast microscopy observations are described for a LiF crystal irradiated to 2×10^{17} nvt and annealed at 400 to 800°C. Previous reports that square cavities with faces parallel to (100) and colored by the interference of light were found densely near cracks and subboundaries while sparsely in subgrains are confirmed. Other observations are reported. Closely formed cavities decorate subboundaries but few are observed within 30 μ of outer surfaces of subboundaries. There are isolated dislocation lines as well as isolated cavities in subgrains, visually observable by having light scatterers. A dislocation network exists near the spot with dense concentration of cavities. Dense arrangements of dislocation lines become observable on subboundaries and near cracks when the crystal is annealed at about 700°C for a short time. (T.R.H)

11739 RADIATION DAMAGE IN STEEL: CONSIDERATIONS INVOLVING THE EFFECT OF NEUTRON SPECTRA. A. D. Rossin (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 137-47(Feb. 1961).

The mechanism of interaction between fast neutrons and atoms of a metal lattice is described. A cross section for the production of vacancies in iron by neutrons, as a function of neutron energy, was derived and shown to be roughly proportional to the product of the neutron energy and the isotropic elastic scattering cross section. The vacancy production cross section was applied to several reactor spectra and the results showed that an appreciable fraction of the radiation damage in crystalline solids, particularly metals, can be caused by neutrons having energies below 1 Mev. Also the assumption that the neutrons responsible for radiation damage have a fission spectrum distribution appeared to be inapplicable in reactor situations. In fact, no quantitative measure of total neutron exposure could be made without knowledge of the spectral shape. Steel was chosen as an example because of the interest in its properties as a function of irradiation, hence the model was developed based on interaction of neutrons with iron atoms. Some important limitations of the method are cited. (auth)

11740 THE EFFECT OF NEUTRON IRRADIATION ON PHASE TRANSFORMATIONS IN CHROMIUM STEEL. B. Weiss-Hollerwöger (Univ., Vienna, Austria). Nukleonik 2: 222-7(Nov. 1960). (In German)

To determine the effect of neutron irradiation on phase transformations, the austenite-martensite transformation at low temperatures, stabilization phenomena, and the tempering behavior of a chromium steel developed for these studies were investigated. The samples from this steel were irradiated in a reactor with doses of 10^{16}, 10^{17}, 5×10^{17}, and 10^{18} neutrons/cm^2, and then the changes were determined by comparative measurements with unirradiated samples. In conclusion, the significance of the results is discussed with the help of thermodynamics and the strain-embryo theory of Cohen. (tr-auth)

11741 PHOTOCONDUCTIVITY OF SILVER CHLORIDE CRYSTALS UNDER PULSED X-RAY IRRADIATION. Alwin E. Michel (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 121: 968-77(Feb. 15, 1961).

The photoconductivity produced by irradiation with 0.2-μsec x-ray pulses is studied in AgCl as a function of temperature (80 to 280°K), x-ray intensity and penetration, field strength, and crystal preparation, in order to obtain information about lifetimes and mobilities of electrons and holes. The photoconductive response can be described by assuming deep electron traps throughout the volume of the crystal and possibly a disturbed surface layer. No hole motion is observed below 250°K; above that temperature the schubweg per unit field is estimated at 5×10^{-6} cm^2/volt. The electron lifetime in crystals grown and annealed in helium is much smaller than in the air-grown samples. Assuming the same mobility in both samples the lifetime at 80°K is 3×10^{-9} sec. At higher temperatures the pulses show long tails, and between 200 and 280°K the saturation time varies exponentially with 1/T. It is assumed that shallow traps exist (~0.08 ev) in a thin surface region which otherwise have a long electron lifetime as compared with the bulk of the crystal. Measurements on crystals doped with 20 ppm Cu^+ indicate that the Cu^+ ions do not act as effective electron traps. On the other hand, the presence of 1 ppm nickel ions reduces the lifetime at 80°K to less than 3×10^{-11} sec, indicating a capture cross section of the nickel ion larger than 300°A^2. (auth)

11742 DEFECTS IN IRRADIATED SILICON. I. ELECTRON SPIN RESONANCE OF THE Si-A CENTER. G. D. Watkins and J. W. Corbett (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 121: 1001-14(Feb. 15, 1961).

The silicon–A center is a major radiation-damage defect produced in "pulled" silicon by a room-temperature irradiation. It is concluded that this center is a lattice vacancy with an oxygen atom impurity bridging two of the four broken bonds associated with the vacancy. Spin resonance arises from an electron trapped in the other two bonds. The spin resonance studies are described. A molecular orbital treatment of the trapped electron wave-function satisfactorily accounts for the observed g tensor, as well as the hyperfine interaction observed with neighboring 4.7% abundant Si^{29} nuclei. The changes in the spectrum of a sample subjected to uniaxial stress are also described. Under stress, the amplitudes of the individual resonance components (which correspond to different orientations of the defect in the crystal) are observed to change. This results from (1) electronic redistribution of the trapped electrons among the defects, and (2) thermally activated reorientation of the defects themselves under the applied stress. These two effects are separated and a quantitative study of their magnitudes and signs, as well as their rates, is given. (auth)

11743 DEFECTS IN IRRADIATED SILICON. II. INFRARED ABSORPTION OF THE Si-A CENTER. J. W. Corbett, G. D. Watkins, R. M. Chrenko, and R. S. McDonald (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 121: 1015-22(Feb. 15, 1961).

The silicon–A center is a major radiation-damage defect produced in "pulled" silicon by room-temperature irradiation. The infrared measurements are presented which, in conjunction with spin resonance measurements, establish the identity of the silicon-A center. A new infrared absorption band is observed at 12 μ in electron-irradiated silicon. This band is shown to be a vibrational band of impurity oxygen in the lattice. Macroscopic and microscopic correlations between the 12-μ band and the spin resonance of the silicon-A center are presented. The macroscopic correlations are of production rate, recovery, etc. The microscopic correlations derive from the absorption of polarized infrared radiation by samples of various crystallographic orientations, subjected to a uniaxial, compressive stress. Partial alignment of the defects is induced by the stress and is detected as a dichroism in the 12-μ band. This alignment is compared to alignment studies in spin resonance measurements. It is shown that the kinetics and magnitude of the response to the stress are the same for the defects observed in both types of measurements. This shows that the 12-μ band arises from the silicon-A center and establishes the configuration of the oxygen in the defect. These results allow a conclusion to be made that the silicon-A center is a lattice vacancy with an oxygen atom bridging two of the four broken bonds associated with the vacancy. The remaining two bonds can trap an electron, giving rise to the spin-resonance spectrum of the defect. The identification of the silicon-A center indicates that the vacancy is mobile in a room-temperature irradiation. (auth)

11744 ABSORPTION SPECTRA OF F_2^-, Cl_2^-, Br_2^-, AND I_2^- IN THE ALKALI HALIDES. C. J. Delbecq, W. Hayes, and P. H. Yuster (Argonne National Lab., Ill.). Phys. Rev., 121: 1043-50(Feb. 15, 1961).

After x-ray irradiation at liquid nitrogen temperature, holes are trapped by forming F_2^- molecule ions in LiF; Br_2^- molecule ions in KBr containing one of the impurities Ag^+, Tl^+, Pb^{++}, or NO_2^-; and I_2^- molecule ions in KI containing one of the impurities listed above. An investigation of the optical and paramagnetic resonance spectra of crystals containing F_2^-, Br_2^-, and I_2^- centers led to an identification of the optical transitions of these centers. The polarizations and relative intensities of the optical absorptions in the X_2^- molecule ion series are discussed with reference to the energy level scheme to be expected for such a species. (auth)

11745 BLEACHING AND RECOVERY OF F CENTERS IN KCl. Loretta E. Silverman and L. I. Grossweiner (Illinois Inst. of Tech., Chicago). Phys. Rev., 121: 1072-5(Feb. 15, 1961).

F centers in KCl are optically bleached at room temperature with a minimum light energy of 20.1 ± 1.0 ev per F center. The F band is recovered on further room-temperature x raying with a minimum energy of 69 ± 5 ev per F center. The increase in the M and R bands during optical bleaching of the F band is nullified upon the recovery of the F band by further x raying. The recovery kinetics are of second order in the number of optically bleached F centers with a rate-constant of $(7.9 \pm 0.8) \times 10^{-20}$ cm^3/F center-sec. The rate law requires an energy transfer from the bulk lattice and is consistent with an exciton mechanism. (auth)

11746 RATE OF ENERGY LOSS AND RANGES OF CARBON AND OXYGEN IONS IN SOLIDS. D. I. Porat and K. Ramavataram (The University, Manchester, Eng.). Proc. Phys. Soc., (London), 77: 97-102(Jan. 1, 1961).

The rate of energy loss of carbon and oxygen ions passing through carbon, aluminum, nickel, silver, and gold absorbers was measured in the energy interval of 0.36 to 3.2 Mev. Ranges of the carbon and oxygen ions in these stopping materials were obtained by numerical integration of the rate of energy loss against energy curve. The relative accuracy of the results was about 2% and the absolute accuracy was better than 5%. (auth)

11747 BEHAVIOR OF CERIUM IONS IN GLASSES EXPOSED TO X-RAYS. Megumi Tashiro, Naohiro Soga, and Sumio Sakka (Kyoto Univ.). Yogyo Kyokai Shi, 68: 169-73 (1960). (In Japanese)

Silicate glasses exposed to high-energy radiation develop three visible absorption bands similar to the F- and V-band in alkali halide crystals. The function of cerium in suppressing formation of these bands was studied spectrophotometrically in glasses with compositions of 20 R_2O, 10 BaO, 70 SiO_2, and 0.03 mole % CeO_2 (R_2O: Li_2O, Na_2O, K_2O). Glass specimens of about 0.1 mm in thickness were irradiated with x rays of 42 kev, 10 ma, and changes of their absorption spectra in the range of 230 to 800 mμ were measured with the Beckman photoelectric spectrophotometer. As the absorption changes were found to be caused not only by color centers but also by other sources such as the valency change of cerium ion, the change due to color centers was separated from the others by heating the irradiated specimen at 150°C for 30 min; the decrease in absorption intensity by the heating was taken as the absolute change of the absorption due to formation of color centers. The experimental results showed that trivalent cerium ions suppress development of the three absorption bands equally. Thus trivalent cerium ions are effective in preventing formation of either of those structural imperfections associated with trapped electrons of positive holes. As to the valency changes of cerium ion itself, a small part of trivalent cerium ions was found to lose their electron upon irradiation by the reaction $Ce^{3+} + h\nu \rightarrow [Ce^{3+}$ with positive hole$] + e^-$. (auth)

PHYSICS

General and Miscellaneous

11748 (AD-242768) ANNOTATED BIBLIOGRAPHY ON THERMOELECTRICITY MATERIALS AND DEVICES. B. H. Nagel (Autonetics Div., North American Aviation, Inc., Downey, Calif.). Jan. 28, 1960. 233p. (EM-5987)

Five hundred and eighty-three annotated references are included on materials and devices for thermoelectricity. Items published in the American and foreign literature, primarily from 1955 to 1959, are included. The abstracts are arranged chronologically. Author and subject indexes are included. (C.H.)

11749 (AFOSR-139) SOME STUDIES ON ARGON, HELIUM AND CARBON DIOXIDE WITH AN INTEGRATED-SCHLIEREN INSTRUMENTED SHOCK TUBE. Jerome Daen and P. C. T. de Boer (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Dec. 1960. Contract AF49(638)-401. 45p. (BN-225).

Using integrated schlieren instrumentation, an investigation was made of shock waves in argon, helium, and carbon dioxide. In argon and helium, a residual signal was observed, which is ascribed to curvature of the shock front in the vicinity of the wall. A discussion is presented of the way in which the curved shock satisfies the boundary conditions and of the resulting flow pattern, which includes a "pressure adjustment region." Preliminary measurements on the variation of the apparent "zone thickness" with density and shock speed in these gases are reported. The importance of the observed shock curvature in measurements of the vibrational relaxation time for gases like carbon dioxide is considered. Preliminary results for the vibrational relaxation times of dry CO_2 are reported for temperatures up to ca. 900°K, and are compared with results obtained by others. (auth)

11750 (AFOSR-TN-60-575) QUANTIZATION OF NONLINEAR SYSTEMS. Technical Note No. 2. I. E. Segal (Chicago. Univ.). May 1960. Contract AF49(638)-666. 71p. (AD-238336)

A direct method of quantization, applicable to a given nonlinear hyperbolic partial differential equation, is indicated. From such classical equations alone, without a given Lagrangian or hamiltonian or a priori linear reference system such as a bare or incoming field, a quantized field is constructed, satisfying the conventional computation relations. While mathematically quite heuristic in part, local products of quantized fields do not intervene, and there are grounds for the belief that the formulation is free from nontrivial divergences. (auth)

11751 (AFOSR-TN-60-877) TRANSITION PROBABILITIES OF MOLECULAR BAND SYSTEMS. XVII. TABULATED KLEIN-DUNHAM POTENTIAL ENERGY FUNCTIONS FOR FIFTEEN STATES OF N_2, N_2^+, NO, O_2, C_2 AND OH. W. R. Jarmain (University of Western Ontario, London. Molecular Excitation Group). July 1, 1960. Contract AF19(604)-4560, Scientific Report No. 5 and Contracts AF49(638)-640 and NONR-2895(00), Scientific Report No. 2. 19p. (GRD-TN-60-498)

Sets of classical turning points, together with the corresponding vibrational energies, are given for the following molecular states: N_2, $X^1\Sigma_g^+$, $a^1\Pi_g$, $A^3\Sigma_u^+$, $B^3\Pi_g$, $C^3\Pi_u$; N_2^+, $A^2\Pi$; NO, $A^2\Sigma^+$, $B^2\Pi_r$; O_2, $a^1\Delta_g$, $b^1\Sigma_g^+$, C_2, $X^3\Pi_u$, $a^1\Sigma_g^+$, $b^1\Pi_u$, $d^1\Sigma_u^+$; and OH, $X^2\Pi_i$. These numbers, which were calculated from series formulas, represent Klein-Dunham potential energy functions for the states listed. The maximum vibrational quantum number varies from 2 to 14, depending on available experimental data. (auth)

11752 (AFOSR-TN-60-1162) ON THE MAGNETOHYDRODYNAMIC BOUNDARY LAYER THEORY. K. T. Yen (Rensselaer Polytechnic Inst., Troy, N. Y.). Sept. 1960. 23p. Contract AF 49(638)-23.

Boundary-layer equations for two-dimensional steady magnetohydrodynamic flows are derived, and some physical problems such as the relative order of magnitude of viscous and magnetic terms, the velocity and magnetic-field boundary-layer thicknesses, etc. are discussed. The momentum and energy integral equations for magnetohydrodynamics are also obtained. Consideration is given to two magnetohydrodynamic flows. The first is the flow over a flat plate analyzed by Greenspan and Carrier, who showed that as the pressure ratio $\beta = (\mu H_0^2/\rho U_0^2)$ approaches 1, the flow is plugged and the magnetic field is annulled. It is shown, however, that another solution exists when the electric conductivity of the fluid is very large and $\beta = 1$. This solution results in a plugged flow but a uniform, undisturbed magnetic field. The second flow is concerned with jet mixing under a magnetic field directed along the jet axis. The flow-plugging phenomenon also occurs. (auth)

11753 (AFOSR-TN-60-1241) IONIZATION YIELD OF LOW-ENERGY HEAVY IONS IN ARGON. J. A. Phipps, L. C. Towle, and R. A. Lowry (Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences). Oct. 1960. Contract AF49(638)-22. 20p. (EP-4419-105-60U)

Presented at the New York Meeting of the American Physical Society, January 27, 1960.

A cylindrical ionization chamber with a differentially pumped open window was used to measure the total ionization yield of low energy heavy ions stopped in a gas. The ionization yield of protons in argon at 25 to 250 kev was determined earlier. Recent results are presented on the ionization yield of argon and nitrogen ions in argon gas at 25 to 100 kev. The average energy per ion pair for argon ions

increases rapidly with decreasing energy in the above range, and at 50 kev it is about three times the value for 200 kev protons. A comparison of the ionization yields in argon of various ions having velocities in the same region is presented. (auth)

11754 (AFOSR-TN-60-1373) ELECTRON SPIN RESONANCE. Roy S. Anderson (Maryland. Univ., College Park). Nov. 1960. 115p. Contract AF 18(600)-1582.

The relatively recent research technique of electron spin resonance is reviewed with particular emphasis on experimental details, such as apparatus and interpretation. The theoretical section discusses the aspects of the method required for both the initiation and the interpretation of experiments. The experimental section considers the details of importance to the design and operation of the apparatus. The following subjects are treated: (1) quantum mechanical description, including energy levels, selection rules, effects of crystalline electrostatic fields and nuclear magnetic moments, and spin relaxation; (2) principles of spectrographs; (3) radiofrequency and microwave components; (4) amplification and detection; (5) magnetic field; (6) sensitivity; and (7) electron-nuclear double-resonance technique. (auth)

11755 (ANL-6262) PHYSICS DIVISION SUMMARY REPORT [FOR] DECEMBER 1960. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 55p.

The operating principle of the tandem Van de Graaff accelerator is discussed. The use and operation of the 4.5-Mev Van de Graaff generator are described. An upper limit was set for the observed mean life of the first excited state of Ca^{43} and a lower limit was set for the partial mean life for decay by E2 transition from the same state. Groups of delayed neutrons from N^{17} precursors were observed at energies of 1.225 and 0.425 Mev, corresponding to β decay to $^3/_2^-$ states in O^{17} in agreement with the shell model. An investigation is reported of the fragmentation of benzene and ethylene with high-energy electrons. The plasma research program is described. The major research described is an experimental study of basic properties of plasmas produced in homogeneous high-frequency electric fields at low pressure. The doublet splittings in He^5, N^{15}, and O^{17} (closed shells plus or minus one nucleon) are adequately explained in terms of the combination of the second-order effect due to the tensor force and the first-order effect due to the L-S potential. (For preceding period see ANL-6235.) (W.L.H.)

11756 (CEA-1677) METHODES ET APPLICATIONS NOUVELLES EN SPECTROSCOPIE D'EMISSION. (New Methods and Applications of Emission Spectroscopy). G. Baudin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1960. 9p.

Emission spectroscopy, an already well-established instrumental analytical technique, has in recent years known important developments. Two main factors are responsible; firstly the demands of metallurgy for purer and purer materials or alloys which are increasingly complex and difficult to analyze by chemical means and secondly, progress in optics, especially in the production of gratings, and in electronics in the field of photomultiplier tubes. All the new applications and methods are not given, but a few among the most representative outside the conventional field are discussed. (auth)

11757 (JINR-D-566) IONIZATION POTENTIALS OF ATOMS. Yu. D. Prokoshkin and I. M. Vasilevsky (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 11p.

Results of measurements of atomic ionization potentials in regions of high-energy incident particles are presented. In determining the ionization potential the ionization losses and the total ranges of protons, deuterons, and α particles were measured. The experiments were performed using a 6-meter synchrocyclotron. Ranges and particle energies are tabulated, along with data on the ionization potential for copper. (J.R.D.)

11758 (JINR-P-312) IZLUCHENIE VAVILOVA-CHERENKOVA. (Vavilov-Cherenkov Radiation). I. M. Frank (Joint Inst. for Nuclear Energy, Dubna, U.S.S.R. Lab. of Neutron Physics). 1959. 22p.

Report Presented at the World Exhibit, Brussels, Aug. 13, 1958.

The text of a lecture given by Nobel Laureate I. M. Frank at the World's Exhibition at Brussels in August of 1958 is presented. The properties of light and matter, the phenomena of luminescence, and the Vavilov-Cherenkov effect are summarized. The exact nature of Cherenkov radiation and its appearance for fast particles penetrating matter are discussed. (TTT).

11759 (LAMS-2504) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING DECEMBER 20, 1960. (Los Alamos Scientific Lab., N. Mex.). Dec. 1960. 18p. Contract W-7405-Eng-36.

An in-pile test program for single-cell plasma thermocouples is discussed in which methods are described for reducing high collector temperatures and for increasing cell efficiencies. Outgassing test results suggested that the fuel pins be heated to operating temperature in high vacuum before installation in test cells. A cell was modified by an extension tube and a sapphire window to permit direct pin temperature measurements by optical pyrometry. The cell was operated for ~50 hr, for which the gas volume increase rate was approximately the same as for previous tests. Further developments discussed for a plane-geometry guard-ring cell were: a redesigned filament to eliminate previous erratic behavior and a means for adjusting anode-cathode spacings. An electrically heated cell is described which was constructed to obtain information on the behavior of UC–ZrC emitters. The cell was designed with a guard-ring collector geometry in order to expose the collector to a small section of plasma characterized primarily by the UC–ZrC emitting surface. A suggestion was made for obtaining estimates of electron temperatures and ion densities by examining the intensity and shape of the recombination radiation curve near the series limits. A relation was found for the electron temperatures which agrees well with observations made with a sapphire window cell. Determinations of relative ion densities show that at ~1 mm Hg cesium vapor, a maximum occurs that is related to, and in qualitative agreement with, the maximum in the saturated positive ion current observed in similar cells. A hypersonic plasma thermocouple was proposed as a low-voltage high d-c electrical power supply. Tests conducted using hot argon gas impinging on the end of a sharpened graphite rod, yielded as much as 3 volts and short-circuit currents of 6 amp. Considerations were given for the development of spherical, light-weight fast reactors suitable for self-radiative space power supplies. Work was begun to determine the spectral and total emissivities and vaporization properties of UC–ZrC systems. The fabrication of two experimental fuel pins is described. Methods developed to facilitate the preparation of ceramic-to-metal seals are discussed. (For preceding period see LAMS-2495.) (B.O.G.)

11760 (NASA-TN-D-585) AN ION ROCKET WITH AN ELECTRON-BOMBARDMENT ION SOURCE. Harold R.

Kaufman (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Jan. 1961. 39p.

An ion-rocket engine with a 10-cm diameter electron-bombardment ion source was investigated. Theoretical and experimental results are presented. Mercury ion exhaust beams up to 0.06 amp were obtained with over-all engine power efficiencies of 0.27 to 0.33 at specific impulses from 4500 to 5500 sec. Use of a more efficient field coil to generate the small magnetic field required could increase these values to about 0.40 and 0.45. Further increases in efficiency appear likely by the improvement of other components. Propellant-utilization efficiencies were as high as 0.80. An electron-bombardment ion source appears to be one of the most promising for ion rockets. (auth)

11761 (NP-9435) FUNDAMENTAL INVESTIGATIONS OF HIGH EXPLOSIVES AND EXPLOSIVES PHENOMENA. Final Report. T. K. Collins (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Sept. 30, 1959. Contract N7-onr-45107. 31p.

A bibliography of 48 entries is presented. Information and data pertaining to an x-ray technique for measuring the density vs. distance relation in the detonation of explosives are presented. (W.L.H.)

11762 (NP-9530) THE PENETRATION OF A WAVE INTO A POTENTIAL BARRIER. Guido Beck (Rio de Janerio. Centro Brasileiro de Pesquisas Físicas). 1960. 9p. (Notos de Fisica VI, No. 6)

The distortion of a wave pulse reflected by a potential step of finite height is determined and given, in a simple case, in closed form. It shows that part of the signal energy becomes temporarily stored inside the potential barrier before it becomes reflected. (auth)

11763 (NP-9731) THE NEUTRALIZATION PROBLEM OF IONIC PROPULSION. Technical Release No. 34-118. Willard H. Wells (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Oct. 3, 1960. 40p. Contract NASw-6.

Electron-ion collisions are an essential consideration in the neutralization problem of ionic propulsion, even for that part of the ionized gas that is much closer to the vehicle than one mean free path. This is because electrons with a history of collisions downstream will diffuse back upstream and will constitute a majority of the electron charge density near the vehicle. An intuitive and semiquantitative treatment indicates that neutralization is relatively easy to accomplish. Important considerations are to locate the electron-emitting filaments in, or as near as possible to, the ion stream and to bias the emitter a few volts positive with respect to the vehicle's external structure. The bias prevents electron loss by assuring that the structures are not accessible to the electrons. The distance of the electron emitter behind the vehicle and the directivity of emissions are not important. The spatial distribution of ions and electrons is studied in an approximate way. The design of tank experiments is discussed briefly. (auth)

11764 (NP-9804) PROPELLANTS FOR ELECTRICAL PROPULSION ENGINES OF THE CONTACT OR BOMBARDMENT ION TYPE. Second Quarterly Report, June 15–September 15, 1960. A. L. Cox (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Oct. 1960. 97p. Project No. 3048. Contract AF33(616)-7063.

An investigation of various organic propellants for an electrical propulsion engine is discussed. The study encompasses propellant property investigations and charged colloid production. Details of analysis, design, experimental procedure, and results are presented. (W.L.H.)

11765 (NP-9845) RESEARCH SUMMARY NO. 36-6, VOLUME II FOR THE PERIOD OCTOBER 1, 1960 TO DECEMBER 1, 1960. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Jan. 2, 1961. Contract NASw-6. 77p.

The influence of electron exchange on the dispersion relation of collective oscillations of a high-density electron gas was calculated. Electron velocity distribution in a partially ionized gas in the presence of time-dependent electric and magnetic fields was determined. Calculations were carried out to determine approximate weights for cavity type fission-electric cell reactors. The relativistic theory of 3-vectors is discussed. The rates of the reactions involving atomic nitrogen and physics were calculated for the upper atmosphere between 70 and 150 km. Relaxation times of the nuclear magnitizations of silicone fluids were measured. The methanolysis of WCl_6 was investigated. The aerodynamic noise radiated by a supersonic turbulent boundary layer was studied. In materials research the reactions of ZrO_2 with Al_2O_3 and the magnetic susceptibility of pyrolytic graphite were investigated. The input power characteristics curves for a plasma generator were determined. The vibration of a circular ring, mode shapes and frequencies of non-uniform beams, and the thermal efficiency of coated fins were calculated. A digital recording instrumentation system and a strain-gage venturi flowmeter are described. Wind tunnel and environmental facility development programs are outlined. Studies of liquid and propellant propulsion including combustion and injection, heat transfer, propulsion ancillaries, system analysis, and six-component stand motor firing are reviewed. (M.C.G.)

11766 (NP-9850) THE PROPERTIES OF DISLOCATIONS IN CRYSTALS. Final Report. R. Thomson (Illinois. Univ., Urbana). Sept. 15, 1960. Contract AF49(638)-420. 18p.

The properties of atoms in the "core" of a dislocation where the distortion of the crystal structure is very high were studied. The rate with which vacancies can be absorbed or created in the crystal from the dislocation core was calculated. The Peierls energy of dislocation was investigated. It was concluded that the Peierls energy in a crystal-like germanium or silicon should be a major barrier for the motion of a dislocation and that the motion should be a thermally activated process. It was found that the Peierls energy is a function of atomic forces to such an extent that there are critical values of the force constants at which the Peierls energy completely disappears. In a study of impurity diffusions in LiF, a crystal was plated on the lower surface with NaCl and a potential applied across the crystal. Three different processes were observed: decomposition of sodium chloride; diffusion of sodium, which occurred along dislocation pipes; and deposition at the top surface. The temperature and stress dependence of the velocities of isolated dislocations in pure germanium and silicon were measured. (M.C.G.)

11767 (NYO-2886) ON THE GREEN'S FUNCTION FOR TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC WAVES. I. Harold Weitzner (New York Univ., New York. Inst. of Mathematical Sciences). Apr. 14, 1960. 32p. Contract AT(30-1)-1480. (MF-10)

The Green's function is evaluated for the Lundquist equations linearized about uniform magnetic field, density, and zero flow. It is further assumed that all quantities vary with two space variables and time only and that the constant magnetic field lies in the plane of the two space variables. (auth)

11768 (NYO-9354) DIFFRACTION OF A HYDROMAGNETIC WAVE BY A HALF PLANE. Clifford S. Gardner

(New York Univ., New York. Inst. of Mathematical Sciences). Sept. 30, 1960. 57p. Contract AT(30-1)-1480. (MF-6)

The diffraction of a weak hydromagnetic shock wave by a rigid perfectly conducting half plane is considered. The medium is assumed to be a perfect compressible fluid with perfect electrical conductivity, permeated by a uniform magnetic field. The medium occupies the space outside a rigid perfectly conducting half plane. The reflected and diffracted waves resulting after an incident weak shock wave strikes the half plane are determined in the linear or acoustic approximation. The problem is solved by means of an extension of the conical-field method, which is well known in the linearized theory of supersonic aerodynamics. The case where the undisturbed magnetic field is parallel to the half-plane obstacle is discussed. The results show the development in time, toward the ultimate steady state, of the phenomena associated with the reflection of a wave from a full plane. In this way a peculiar feature of hydromagnetic waves is elucidated; namely, that sometimes the reflected wave is on what appears to be the wrong side of the obstacle, the opposite side from the incident wave. (auth)

11769 (OOR-2443:1) A STUDY OF THE SCINTILLATION PROCESS IN VERY FAST PHOSPHORS. Final Report Covering the Period October 20, 1959 to October 19, 1960. Bernard J. Dunn and Daniel F. McDonald (Fordham Univ., New York). 81p. Project 2443-P Contract 30-069-ORD-2869.

Apparatus is described for fast electron-beam excitation of organic scintillators. A special cathode-ray tube is used to provide a beam current of 1 ma at up to 55 kv. The electron-beam apparatus is used to study the rise time of the scintillation pulse in scintillator solutions of anthracene in benzene and p-terphenyl in toluene. The theory of energy transfer in liquid solutions of Kallmann and Furst predicts a dependency of rise time on concentration. The rise time is a measure of the rate of filling of excited levels in the scintillator solute by energy transfer from the initially excited solvent. Observed rise-time variations agree with the theory of Kallmann and Furst. (auth)

11770 (ORNL-3047) ELECTRONUCLEAR RESEARCH DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 1, 1960. (Oak Ridge National Lab., Tenn.). Feb. 15, 1961. 90p. Contract W-7405-eng-26.

Heavy ions (27-Mev N^{3+}) produced in the ORNL 63-in. Cyclotron are used in investigations of heavy-ion elastic scattering, the evaporation of light particles, and nucleon-transfer and -exchange reactions. Surface-barrier counters are under development for use as heavy-ion detectors. For work with 22-Mev protons from the ORNL 86-in. Cyclotron, a selective counting system permits simultaneous recording of proton, deuteron, triton, and α-particle spectra; data are recorded for computer analysis. Present studies concern (p,d), (p,t), and (p,α) reactions, anomalous scattering, and elastic scattering from isobars. Studies of elements in the rare-earth group continue with a study of the nuclear levels in Yb^{169}. Design problems for the construction of spiraled sector coils for Cyclotron Analogue II were solved. The major components of this azimuthally-varying-field, ~500-kev electron cyclotron were designed and are now being fabricated. Construction of the Oak Ridge Isochronous Cyclotron is well advanced. A cyclotron building is being built, the main magnet was fabricated and is undergoing testing, and other components are being designed and fabricated. Precise field measurements in a quarter-scale magnet are in use to determine the design of the complex pole-tip windings required for isochronous operation for a wide range of particles and energies. (For preceding period see ORNL-2740.) (auth)

11771 (SADTC-1960/TM-5) THE EFFECT OF NUCLEAR EXPLOSIONS ON RADIO COMMUNICATION. H. P. Williams (SHAPE Air Defense Technical Center, Hague). July 1960. 61p. (AD-241487)

An explosion in the lower ionosphere of a nuclear bomb in the megaton range will convert midnight ionization conditions into noon conditions. As a result long-range transmissions in the region 100 kc/sec to 2 Mc/sec suffer appreciable attenuation and are likely to be unserviceable not only for the whole night but also for the next night or two. HF ionospheric communications are also severely affected and a virtually complete black-out occurs over an area of some 10 million square kilometers for some hours. It would appear that the higher HF frequencies say, 20 Mc/sec, will escape full extinction if their point of reflection is at least 1000 km from the explosion. On the other hand, there is no reason to suppose that VHF ionoscatter links would have suffered to any measurable degree. In order to black out ionoscatter communications with certainty, the bomb must have some 100 times the residual radioactivity. The proportion of fission material in the Johnston Island 4-MT bomb is not known, but it seems probable that this factor of 100 would require a "dirty" bomb with a power of some 40 MT. (auth)

11772 (SCTM-362-60(72)) THE LATEST DEVELOPMENT IN THE ELECTROLUMINESCENT DISPLAY OF TIME READOUT SYSTEM. LeRoy C. Meyer (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 21p.

A discussion is given on the development of a system for using electroluminescent indicators for digital display of timing information on motion picture film. It was found that a display, in the form of a matrix of dots, could be contact printed onto color film with an exposure time of 1 msec. (auth)

11773 (SCTM-367-60(14)) SPACE CHARGE PRODUCED BY CATHODE EMISSION. R. M. McGehee (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 19p.

The electron charge between two plane-parallel electrodes, produced by thermionic emission from one electrode, is determined. Universal functions of a characteristic parameter are derived, which are applicable to any combination of electrode spacing, cathode temperature, and cathode work function. (auth)

11774 (SCTM-375-60(72)) TUNNEL DIODE APPLICATIONS TO LOGIC AND PULSE CIRCUITS. I. W. Janney (Sandia Corp., Albuquerque, N. Mex.). Dec. 1960. 35p.

An examination was made of the use of tunnel diodes in logic and pulse circuits. This included both a study of the available literature and some theoretical and experimental work. Measurement of some of the device characteristics was investigated. The results of this work are summarized. (auth)

11775 (SCTM-384-60(71)) THE DETERMINATION OF AERODYNAMIC STABILITY COEFFICIENTS FROM ROCKET FLIGHT TEST DATA. A. C. Bustamante (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 19p.

A method is presented by which aerodynamic stability coefficients can be determined from rocket flight test data. A comparison is given between these coefficients and wind tunnel test coefficients. The method is presented with the intention that it be used as a program for the IBM 704 computer. The analysis is general enough to be applicable to any rocket. (auth)

11776 (TID-6266) CYLINDRICAL SHIELDS. Ronold King and Charles W. Harrison, Jr. (Sandia Corp., Albuquerque, N. Mex.). April 28, 1960. 13p. Contract AT(29-1)-789. (SCDC-1029)

The effectiveness of an imperfectly conducting cylindrical shield of small cross section depends on both the attenuation through the metal wall of the externally maintained field and on the amplitude of the current that is induced in the cylinder. When the length of the cylinder, which behaves like a linear scattering antenna, approaches a resonant value, the currents induced in the walls and the field inside the tube are relatively large. Under these conditions large currents may be induced in a thin dipole placed coaxially within the shield. (auth)

11777 (TID-6333) THE THOMAS-FERMI METHOD FOR EQUATION-OF-STATE CALCULATIONS. Robert D. Cowan (Los Alamos Scientific Lab., N. Mex.). Mar. 11, 1960. Decl. Apr. 5, 1960. 10p.

One method of calculating equation-of-state data theoretically is through the application of Thomas-Fermi statistical theory. Data obtained from this method can be expected to be reasonably accurate only at densities greater than two to four times mormal solid density or at temperatures greater than five to twenty volts. This is outside the range of primary interest for present considerations. The method is used as a guide for extrapolating experimental data or theoretical data valid in other density-temperature ranges. (W.L.H.)

11778 (TID-6443) THE NORMAL, RIGID BODY FUNCTIONS OF FREE AND FREE-PINNED BEAMS. J. F. Springfield (Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences). Aug. 1960. 13p. (EP-4422-116-60U)

Solutions for the normal rigid body modes of certain supported elastic beams are constructed. There results a consistent guide for identifying the modes. Finally, an example demonstrating the effect of rigid body modes is given from which one can conclude that the complete solution for free-free and free-pinned beams must include the rigid body modes. (auth)

11779 (TID-6824) THE TRANSFER OF ATMOSPHERIC OZONE INTO THE TROPOSPHERE. A. W. Brewer (Massachusetts Inst. of Tech., Cambridge). May 1, 1960. Contract AT(30-1)2241. 16p.

A study of the transfer of sunlight-created ozone into the troposphere was conducted. It is noted that ozone is created in the atmosphere at about the same levels that megaton nuclear weapons deposit their debris. Mechanisms are described as apparently available for the final transport of ozone into the troposphere. Some of these mechanisms give the main efflux near the subtropical jet, and all give varying rates of outflow. (J.R.D.)

11780 (TID-6891) A HIGH INTENSITY EXPLOSIVE LIGHT SOURCE. Poulter Laboratories Technical Report 009-60. Zev Pressman (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). Sept. 6, 1960. 15p.

The design and performance of several devices for producing high levels of brightness were examined to develop a light source for normal exposure of color film for individual frame exposure times of about 2 μsec with 100 μsec maximum lifetime. The most satisfactory explosive candle design was a 30-in.-long truncated square base pyramid, tapering from the narrow back end to the front end, which was sealed by Plexiglas. Folded sheet configurations of high explosives were used to drive strong interacting shock waves through argon to produce uniform high luminosity for greater than 100 μsec. (J.R.D.)

11781 (TID-11028) THE CONNECTED DIAGRAM EXPANSION OF THE GRAND PARTITION FUNCTION AND THE STATISTICAL MECHANICS OF THE ELECTRON GAS (thesis). Arthur Y. Sakakura (Colorado. Univ., Boulder). May 1960. 137p.

The connected diagram expansion of the grand partition function, generalized to include many-component systems with external fields, was obtained by means of second quantization and Wick's theorem. This was accomplished by expanding the iterative solution of the Bloch equation into a sum of normal products and by directly evaluating the traces of these normal products; the contraction symbol for fermions and bosons is the sum of two contraction symbols, one arising from the expansion in normal products and the other from the evaluation of the traces. An alternative derivation for the fermions based on the hole formalism was also given. Rules for constructing the contribution to log Z from a particular diagram were given in both the configuration and momentum spaces. For the case of pair interactions alone, the diagrams were simplified by the separation into the irreducible diagrams and the polarization parts in analogy with the ground-state theories. The integral equation satisfied by the polarization parts was derived, and the rules for computing the eigenvalues of this integral equation were given. It was shown that the lowest order eigenvalues yielded the Montroll-Ward ring contributions. With the inclusion of the first- and second-order irreducible diagrams, the ground-state energy of the electron gas was derived to second order. The role of the chemical potential in the elimination of contributions not encountered in the direct ground-state energy derivations was discussed. The ring contribution to the grand partition function containing all possible combinations of the first-order exchange interactions is obtained by including the eigenvalues corresponding to kernels with one internal line. From this the equation of state and the internal energy of the electron gas in the near classical limit were extended to include terms of orders $\Lambda\gamma$, γ^4, and $\Lambda\gamma^2$. A method of absorbing all passive particle interaction into a contraction symbol was given, and a simple ladder diagram was summed. (auth)

11782 (TID-11687) STUDIES IN MOLECULAR SPECTROSCOPY. Report of Progress from May 1, 1960–April 30, 1961. Walter F. Edgell (Purdue Univ., Lafayette, Ind.). 13p.

The grating Raman spectrograph, designed for the study of metal carbonyls and derivatives, was completed. A qualitative molecular orbital theory of the bonding in metal carbonyls was developed and used to interpret vibrational spectra. The work on the atomic orbitals for the transition metals Cr, Mn, Fe, Co, and Ni in a number of stages of ionization was completed. Major improvements were made in the digital computer program for treating the vibration of larger molecules. Studies of the changes in C ≡ C and C–H bands, which resulted from changes in the R group in molecules of the type R–C ≡ C–H, were made. The very weak infrared bands of $HCo(CO)_4$ and $DCo(CO)_4$ were studied in order to locate almost all of the fundamentals, including Co–H and Co–D stretching vibrations. Infrared spectral studies were begun on the $Fe(CO)_3\,NO^-$ ion and on $Ni(CO)_3\,NO_3$ in order to determine what fundamental changes occur in bonding when one or more of the CO groups is replaced by NO. (M.C.G.)

11783 (TID-11722) ELECTRIC FIELD GRADIENTS IN POINT-ION AND UNIFORM-BACKGROUND LATTICES. F. W. de Wette (Illinois. Univ., Urbana). [1960?]. 43p.

The lattice contribution to the field gradient in ionic

crystals and metals may be evaluated by breaking the field gradient up into a number of conditionally convergent series with poor convergence, and applying the method of "plane-wise summation." The method is applied to the field gradient in ionic crystals with tetragonal and hexagonal symmetry and to the field gradient in tetragonal and hexagonal close-packed metal structures. As an example, an expression for the field gradient at the position of the anion is derived for ionic crystals with the CdI_2-structure. This expression is numerically evaluated for $CoBr_2$, $FeBr_2$, $MgBr_2$, $MnBr_2$, CaI_2, CdI_2, CoI_2, FeI_2, GeI_2, MgI_2, and MnI_2. Numerical results are presented for both close-packed metal structures, including values for the field gradient in Li, Be, Zn, In, and Rh. (auth)

11784 (TID-11727) IRREVERSIBLE STATISTICAL MECHANICS OF SPIN-SPIN RELAXATION. Technical Report No. 2. Robert L. Peterson (Case Inst. of Tech., Cleveland). Nov. 1960. 44p. Contract AT(11-1)-623.

The equations of motion describing spin-spin relaxation were determined for a system of spin-$\frac{1}{2}$ particles in a crystal, using the hypothesis that the approach to equilibrium is a result of the displacements of the spins from their lattice sites. A set of irreversible rate equations, from which the equations of motion are obtained, was derived by a second-order perturbation expansion of the quantum mechanical Liouville equation in a representation in which interactions with external fields are diagonal and with the spin displacements as the perturbation. No random phase assumption was used, the statistical nature of the spin displacements playing a largely similar role. It is found that the rate equation for the diagonal elements of the density matrix becomes the master equation with detailed balance, plus a term that is unevaluated within the formalism and which is necessary for a correct description of equilibrium values. The rate equations for the off-diagonal density matrix elements are very simple, contain no unevaluated terms, and apparently are new. The equation of motion for the longitudinal component of the spin is obtained from the diagonal rate equation, and a phenomenological expression for the equilibrium value is used. The transverse equations are coupled and have a different form from that often considered. All parameters in the expressions for the spin-spin relaxation times can be calculated. In the general case, the relaxation times depend in a complicated manner upon the lattice temperature, the magnitude of a constant magnetic field, and the frequency and amplitude of an oscillating field such as is used in nonresonance absorption measurements. For a sufficiently strong magnetic field, the relaxation times increase with increasing magnetic field essentially as predicted earlier by Kronig and Bouwkamp, i.e., approximately as $\exp(aH^2)$. In certain cases the relaxation times should also be approximately inversely proportional to the lattice temperature. This can explain some of the results of nonresonance absorption measurements on alums. (auth)

11785 (USCEC-83-201) THE STRUCTURE OF STRONG SHOCK WAVES OF STABLE MONATOMIC MOLECULES. Toyoki Koga (University of Southern California, Los Angeles. Engineering Center). Oct. 1960. Contract AF49(638)-831. 68p. (AFOSR-TN-60-1344)

An accepted theory of plane shock waves of monatomic gas is presented which is based on the hypothetical assumptions that the distribution function $f(c_x, c_y, c_z)$ is separable and $f = f_x(c_x) f_{yz}(c_y, c_z)$, where the main flow is in the x-direction; the characteristics of f_x are evaluated by the degree of unsymmetry; and for the collision term of the Boltzmann equation, an approximation similar to that proposed by Bhatnagar and others is taken. It is proposed that the persistence of state of a particle after its collision is to be taken into account. According to the first two assumptions, two series of distribution functions are designed. There is no serious mathematical difficulty in solving five equations of moments by which the five unknown variables involved in an assumed distribution function are determined. The results are compared with those of other authors. (auth)

11786 (USNRDL-TR-463) THEORETICAL MODEL FOR MOLECULAR AND PARTICULATE INTERACTION WITH WATER AEROSOL. R. Caputi (Naval Radiological Defense Lab., San Francisco). Sept. 19, 1960. 30p.

A mathematical model is derived describing the scavenging mechanism of the rare gases, their precursors, and their radioactive daughters by a water aerosol. A major premise of the model is the applicability of the kinetic theory of gases, and it considers only those cases where the solid particulate is sufficiently dispersed such that kinetic theory can be applied. The final results of the derivation are given in the form of three rate constants for the scavenging rate of the solid particulate by the water aerosol and the exchange rates of the gas between the water droplets and the surrounding atmosphere. By the use of these rate constants and the differential rate equations, the concentration distribution as a function of time, droplet radius, droplet density, and temperature for a nuclide is derived. (auth)

11787 (AEC-tr-4442) CALCULATION OF THE ISOTOPIC EFFECT IN THE VAPOR PRESSURE OF WATER AND METHANE. G. G. Deviatykh. Translated by Helen J. Chick and Wesley M. Jones (Los Alamos Scientific Lab.) from Zhur. Fiz. Khim., 31: 1445-7(1957). 5p.

Calculations were made of the effect of hydrogen and oxygen isotope substitutions in water and hydrogen and carbon isotope substitutions in methane on the vapor pressure for the triple point. The results agree with experimental values. (T.R.H.)

11788 (CEA-tr-A-833) UN ARC CYLINDRIQUE POUR GRANDES PUISSANCES. (A Cylindrical Arc for High Powers). H. Maecker. Translated into French from Z. Naturforsch., 11a: 457-9(1956). 7p.

For the measurement of properties of matter at very high temperatures, it is desirable to have a symmetrical arc with very rigorous axial symmetry at high power. In this region the principle of the stabilization of walls, with the aid of transparent tubes, is used. An apparatus is described which permits the utilization of this system in spite of the low load capacity of transparent tubes. In this apparatus the tube is formed of plates of perforated copper. These plates are mounted insulated from each other so that they form a cylinder. They are cooled internally by a water current. In this tube the arc is stable and can attain powers of the order of 10 kw along the arc. (tr-auth)

11789 (CEA-tr-R-525) CIBLES D'HYDROGÈNE SOLIDE À LA SURFACE DES ÉMULSIONS PHOTOGRAPHIQUES. (Targets of Solid Hydrogen at the Surface of Photographic Emulsions). V. A. Otroshchenko, V. A. Sviridov, K. D. Tolstov, and A. I. Shalnikov. Translated into French from Pribory i Tekh. Ekspt., No. 6, 110-11(1957). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 10861.

11790 (CEA-tr-R-526) EFFET ISOTOPIQUE DE LA VISCOSITE DES LIQUIDES. (Isotope Effect on the Viscosity of Liquids). A. E. Lutskii and E. M. Obukhova (Oboukhova). Translated into French from Ukrain. Khim. Zhur., 25: 274-5(1959). 5p.

Conclusions drawn from the experimental data on the critical temperature and viscosity of deuterium compounds and their binary compounds (Ravikovich and Solomko, Ukrain. J. Chem., 24: 7(1958)) create certain objections. Specifically, the conclusion that the viscosity values confirm approximately the deductions of the theoretical principles concerning the proportionality of the dynamic viscosity to the square root of the molecular mass is questioned. The results, which confirm the validity of the theoretical deductions, were indicated on the normal and deuterated compounds of CH_4 and C_6H_{12}. (J.S.R.)

11791 (CEA-tr-R-1072) ETUDE DES SPECTRES PRODUITS PAR LA DECHARGE ELECTRIQUE DE HAUTE FREQUENCE DANS LES GAZ ET LES FLAMMES A PRESSION ATMOSPHERIQUE. (Study of Spectra Produced by High-frequency Electric Discharge in Gases and Flames at Atmospheric Pressure). V. S. Rossikhin and T. L. Tsikora. Translated into French by S. Zarfin from Zhur. Fiz. Khim., 29: 1079-86(1955). 20p.

A study was made of the spectra produced in high-frequency discharge in air, carbon dioxide, acetylene, and air-acetylene mixture at atmospheric pressures. The elementary processes produced during this discharge and, in particular, the mechanism for the formation of free radicals such as C_2 and CH, were determined. These radicals are formed in a discharge in CO_2 only when there is complete dissociation of the molecules CO_2 or CO. The formation of the radical C_2 and of solid carbon occurs in a flame by two different mechanisms. The formation of the radicals C_2 and carbon particles shows simultaneous and independent processes. The most probably mechanism for the formation of CH in a flame is $C_2 + OH = CH + CO$. (J.S.R.)

11792 (CEA-tr-R-1133) RECHERCHES DE LA SENSIBILITE DES EMULSIONS DE TYPE P A DIFFERENTES CONDITIONS DE TRAITEMENT. (Investigation of Sensitivity of P Type Emulsions to Various Conditions During Processing). D. M. Samoilovich, E. S. Barinova, A. A. Vlasov, and O. P. Inkhnovskaya (Inkhnovskaia). Translated into French from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 5: No. 1, 56-7(1960). 7p.

A study was made of the loss of sensitivity of unsupported emulsions during development in the unmounted state. It was found that development without support results in uniform sensitivity. During drying after mounting, there is a regression of the tracks. In development immediately after mounting, there is no regression. The regression during drying is conditioned by the high humidity at the surface. (T.R.H.)

11793 (CEA-tr-R-1155) DÉTERMINATION DE LA CONSOMMATION D'ÉNERGIE PAR RAYONNEMENT D'IONISATION LORS DE LA FORMATION DE L'ARGENT DE L'IMAGE LATENTE PHOTOGRAPHIQUE. (Determination of the Energy Consumption by Ionizing Radiation in Photographic Emulsions.) K. S. Bogomolov, N. V. Maslennikova, I. F. Razorenova, and N. V. Anassova. Translated into French by Y. Kefeli from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 2: 408-12(1957). 15p.

A study was made of the energy consumption for formation of metallic silver of the latent image in halide emulsions. The silver produced by electrons of various energies was determined electrolytically. A second series of experiments used light and electrons. The value for the quantum yield of silver for visible light is 0.5 and is characteristic for each actual photographic film. (T.R.H.)

11794 (SCL-T-345) THE ELECTRIC STRENGTH AT THE EDGE OF THE PLATE CONDENSER. A Contribution to the Theory of the Spark Gaps and Conduction. W. Rogowski. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, New Mex.). from Arch. Elektrotech., Vol. XII, No. 1, 1-15(1923). 26p.

The potential of the finite plate condenser is determined by Maxwell's solution. The equation applies to very thin (infinitely thin) electrodes. Kirchhoff originated another, completely different, solution that makes it possible to take into consideration the thickness of electrodes also. Kirchhoff's solution is adapted to infinitely thin electrodes in deriving the field intensity distribution at the rim of the condenser (Maxwell's solution). The two solutions are used to determine the influence of electrode thickness. (W.L.H.)

11795 (UCRL-Trans-435(L)) THE DIFFUSION OF LIGHT BY ATOMS. H. A. Kramers. Translated from Atti congr. intern. fis., Como, 1927, 2: 545-57(Sept. 1927). 10p.

Theoretical remarks on phenomena linked to the propagation of light waves in a material medium are presented. The theory of dispersion, i.e., the formula that specifies the manner in which the index of refraction of a medium, homogeneous and isotropic, depends on the frequency of the waves, is treated. (W.D.M.)

11796 MAGNETIC STRUCTURES OF 3d TRANSITION METAL DOUBLE FLUORIDES, $KMeF_3$. Vladimiro Scatturin, Lester Corliss, Norman Elliott, and Julius Hastings (Brookhaven National Lab., Upton, N. Y.). Acta Cryst., 14: 19-26(Jan. 10, 1961). (BNL-4404). (In English)

The antiferromagnetic structures of $KCrF_3$, $KMnF_3$, $KFeF_3$, $KCoF_3$, $KNiF_3$, and $KCuF_3$ were obtained by neutron diffraction. The manganese, iron, cobalt, and nickel double fluorides exhibited an order in which the divalent 3d ion was coupled antiferromagnetically to its six nearest neighbors. In the chromium double fluoride, the magnetic structure consisted of ferromagnetic (001) sheets, coupled antiferromagnetically along the [001] direction. No magnetic scattering was observed in the neutron diffraction pattern of the copper double fluoride. The magnetic structures and the observed crystallographic distortions are discussed in terms of an indirect exchange mechanism and in terms of the crystal field theory, respectively. (auth)

11797 SCHWINGER'S EQUATION FOR ONE-BODY PROPAGATOR OF A SELFCOUPLED SPINOR FIELD. G. Pócsik (Roland Eötvös Univ., Budapest, Hungary). Acta Phys. Acad. Sci. Hung., 12: 181-3(1960). (In English)

The renormalization problems of the Thirring model, completed by a meson-fermion derivative coupling, was previously investigated, and the many-particle propagators originating from the derivative coupling were determined by means of a non perturbative treatment. The nonperturbative treatment of the self-coupled spinor field must still be considered. As a preliminary step the Schwinger equation of the one-body propagator was deduced by a nonperturbative method. The external source method was used. As the equation obtained shows some features which differ from those of the corresponding equations of quantum electrodynamics and meson theories, the Schwinger equation must be of the second order. (J.S.R.)

11798 ZEROTH LAW OF THERMODYNAMICS. Louis A. Turner (Argonne National Lab., Ill.). Am. J. Phys., 29: 71-6(Feb. 1961).

The following is shown with respect to the zeroth law of thermodynamics. (1) Planck's argument that it follows from a general theorem concerning establishment of thermal equilibrium among numerous bodies does not appear to be conclusive. (2) The zeroth law is a consequence of the first and second laws in classical thermodynamics and

need not, therefore, be considered as a separate assumption or law. (3) The zeroth law must be assumed as supplementary to the second axiom in Carathéodory's theory, as Carathéodory did, if one wishes to adhere to that axiom precisely as he gave it. If, however, the axiom be amplified slightly in a natural way, the zeroth law can be derived as a consequence. (auth)

11799 MATTER AT HIGH DENSITIES. E. E. Salpeter (Cornell Univ., Ithaca, N. Y.). Ann. Phys. (N. Y.)., 11: 393-413(Dec. 1960).

The equation of state of matter in its most stable form at different densities ρ and at zero temperature is discussed. Using effective range theory and the low density limit of the nuclear many-body formalism, the energy and pressure of a neutron gas are calculated at densities where the interparticle distance is large compared with the effective range. Energy and pressure of a neutron gas at densities comparable to nuclear densities are estimated, using a semiempirical method. Most probably neutron matter is not bound at any density. Coulomb effects and the effect of β decays are considered and it is found that free neutrons are at equilibrium with ionized nuclei like Tc^{145} at a density of about 3×10^{11} g/cc with an electron Fermi energy of about 23 Mev. For the unlikely case of bound neutron matter an "electron skin" surrounding large neutron drops contributes a negative surface tension and neutron drops of radius about 100 fermis would probably be most stable. At densities above 10^{15} g/cc, hyperons coexist with protons and neutrons and their effect on the pressure is considered. At very high densities, a simple approximation is given for the pressure caused by the proximity of the hard repulsive cores of nuclear forces. (auth)

11800 ANOMALOUS MELTING PROPERTIES OF He^3. R. L. Mills, E. R. Grilly, and S. G. Sydoriak (Los Alamos Scientific Lab., N. Mex.). Ann. Phys. (N.Y.), 12: 41-55 (Jan. 1961).

Measurements on He^3 from 0.3 to 1.2°K were made of: the melting pressure; the volume change on melting; and the molar volume, compressibility coefficient, and thermal expansion coefficient of the liquid at melting. Pressures were transmitted by a spring-loaded bellows, and temperatures were controlled by a liquid He^3 bath. A minimum in the melting curve was observed at 28.91 atm and 0.330°K. The thermal expansion coefficient of solid He^3 was shown to be negative below a melting temperature of 1.0 to 1.2°K. Other anomalies in the PVT melting properties of liquid and solid He^3 associated with the melting curve minimum are discussed. (auth)

11801 ELECTROMAGNETIC RADIATION FROM A FREELY GRAVITATING CHARGE. Asher Peres (Israel Inst. of Tech., Haifa). Ann. Phys. (N.Y.), 12: 86-90(Jan. 1961).

It is shown that a charge, accelerated by a gravitational field, radiates as if it were accelerated by any other external force. General relativistic effects appear only as corrections, which can be neglected for slow motions in weak fields. The bearing of this fact upon the equivalence principle is discussed in relation to a recent paper of DeWitt and Brehme. (auth)

11802 PERIODIC ELECTROMAGNETIC AND QUANTUM SYSTEMS. Robert M. Bevensee (Univ. of California, Berkeley). Ann. Phys. (N.Y.), 12: 222-63(Feb. 1961).

A new analysis of periodic electromagnetic structure is developed which is based on their resonant properties rather than their traveling wave properties. By expanding the fields of Maxwell's equations in a set of short-circuit modes, defined as the resonant modes within a unit cell of the structure bounded by electric shorting planes on the coupling surfaces and excited by tangential electric field on those surfaces, a determinantal equation for $k^2 = \omega^2\mu_0\epsilon_0$ is obtained for a given periodic phase shift ϕ. Alternately, the fields are expanded in a set of open-circuit modes, defined as the resonant modes within a unit cell with magnetic shorting planes on the coupling surfaces and excited by tangential magnetic field on those surfaces. The same determinantal equation for $k^2(\phi)$ is obtained. These theorems for a general symmetric structure are proved: (1) the irrotational modes with zero curl are not necessary for determining the passband curves; (2) the shape of a narrow passband is a simple $(1 \pm \cos \phi)$ curve between the cutoff frequencies, independent of the coupling between cavities; and (3) the sum of all the $k^2(\phi)$ associated with the passbands is the sum of all the k^2 lying on the $(1 \pm \cos \phi)$-curves between the actual cutoff frequencies, independent of the nature of the coupling. The determinantal equation for $k^2(\phi)$ can be obtained from variational expressions for k^2, and these lead by analogy to a variational expression for the energy of a periodic quantum system. The Schrödinger equation for the first energy band of an infinite line of positive ions is solved in terms of the first "short-circuit" and "open-circuit" eigenfunctions to illustrate the analysis. Then a cellular procedure is outlined for solving Schrödinger's equation variationally within a unit cell of a more complicated crystal. The procedure provides for continuity of both $\hat{\Psi}$ and $\nabla\hat{\Psi}$ over the whole surface of a unit cell and should prove useful for many crystals with unit cells of arbitrary shapes, described by very general hamiltonians. (auth)

11803 POWER PLANTS FOR OUTER SPACE. John M. Allen (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev., 10: No. 2, 3-8(Feb. 1961).

The types of energy-conversion systems available for use in outer space are surveyed. The factors affecting selection of a system are outlined, and a tabulation is given of energy sources versus storage potential and form of energy delivered (thrust, electric, mechanical, chemical, and thermal). The discussion is divided into sections on solar energy, nuclear energy, chemical energy, and thermomechanical cycles. (T.R.H.)

11804 NOTES ON THE UNIFIED FIELD THEORY. J. Pachner (Technical Univ., Prague). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 8: 471-6(1960). (In English)

The unification of the gravitational and electromagnetic fields into one geometrical field became possible after the asymmetric affine geometry had been substituted for the Riemann geometry of the general relativity theory. The unified field theory was built up from these factors and is now supplemented by the present work. The postulates of the unified field theory of gravitation and electricity and the choice of the Hamiltonian, the number of universal natural constants in the field theory of gravitation and electricity, and the meaning and the limits of the unified field theory of gravitation and electricity are analyzed. (J.S.R.)

11805 THE EXPRESSION OF SOME PERIODIC SOLUTIONS OF THE THIRD TYPE OF THE THREE-BODY PROBLEM. Jean Grémillard (Faculté des Sciences, Besancon, France). Compt. rend. 251: 2121-3(Nov. 14, 1960). (In French)

A study is made of a particular case where the third type periodic solutions of the three-body problem can exist. The orbit elements being given by a system of four equations with five variables defining four of these as a function

of the fifth ("oblique" variable), the expressions of these variables are given in the case where two hessians are simultaneously zero. (tr-auth)

11806 STRESS CONCENTRATION IN A SPHERICAL SHELL AROUND AN ELLIPTICAL HOLE OF SMALL ECCENTRICITY. G. N. Avin and G. A. Fo-Fu Wang (Inst. of Mechanics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 10, 1340-3(1960). (In Ukrainian)

A solution was found for the problem of stress concentration around an elliptical hole of small eccentricity in a spherical shell subjected to uniform pressure. A numerical example is presented which illustrates the effect of the eccentricity of the concentration of forces on the contour. (auth)

11807 SPHERICALLY SYMMETRIC CHARGE DISTRIBUTIONS. B. C. Carlson (Ames Lab., Ames, Iowa). Iowa State J. Sci., 35: 319-30(Feb. 15, 1961). (IS-111).

The classical electrostatic self-energy of a spherically symmetric charge distribution is written as the integral of an energy density that differs from the usual squared electric field strength. This density vanishes in empty space surrounding the charge distribution. It is sometimes a convenient choice for integration, as is shown by two examples of interest in nuclear physics: the harmonic-well distribution and the distribution with Fermi shape. The self-energy of the Fermi distribution is given to good accuracy by a polynomial of fifth degree in the skin thickness. The form of the energy density is generalized to be valid for distributions not having spherical symmetry. (auth)

11808 THE AUGER EFFECT. M. A. Listengarten. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1041-75(Sept. 1960). (In Russian)

Classifications of Auger electrons, their energies, relative intensities of lines and groups of Auger electrons, and the absolute magnitude of Auger effect probabilities (energy width) are reviewed and analyzed. The saturated part of primary vacancies emitting Auger electrons (the Auger yield) and the part emitting x radiation (the fluorescence yield) are discussed. 116 references. (R.V.J.)

11809 INFLUENCE OF TENSOR CONDUCTIVITY ON CURRENT DISTRIBUTION IN A MHD GENERATOR. H. Hurwitz, Jr. (General Electric Research Lab., Schenectady, N. Y.), R. W. Kilb, and G. W. Sutton. J. Appl. Phys., 32: 205-16(Feb. 1961).

Magnetohydrodynamic generators may operate under conditions such that the product of electron cyclotron frequency and mean collision time is not small compared to unity. Accordingly the electrical conductivity is a tensor rather than a scalar quantity. The influence of tensor conductivity on the electrical current distribution has been investigated in two idealized situations, one pertaining to the entrance and exit regions of the generator and the other pertaining to the region near segmented electrodes. The calculations predict modifications of the internal impedance of the generator which can be described in terms of increases in the effective duct length and width. (auth)

11810 COUPLED MODE THEORY OF ELECTRON-BEAM PARAMETRIC AMPLIFICATION. R. W. Gould (California Inst. of Tech., Pasadena) and C. C. Johnson. J. Appl. Phys., 32: 248-58(Feb. 1961).

A theory of parametric amplification in a filamentary electron beam by transverse fields is developed in coupled-mode form. Space charge effects are neglected. In addition to beam modes at the signal frequency, beam modes at frequencies $\omega_n = \omega + \omega_p$, $n = 0, \pm 1, \pm 2 \cdots$, where ω_p is the pump frequency, are coupled together. A discussion of the general form of the equations is given and reveals the circumstances under which exponential gain or periodic energy transfer between various modes can occur. When the theory is applied to quadrupole electric pump fields, a description of the quadrupole amplifiers of Adler, Wade, and Gordon is obtained. This theory is then used to evaluate the noise contribution from synchronous beam modes and higher cyclotron idler modes. Coupling by axially symmetric electric fields and by axially symmetric magnetic fields is discussed, and other amplification schemes are suggested. The theory of coupling by axially symmetric fields can also be used to study lens effects on noise in the gun region. (auth)

11811 DEPENDENCE OF CALCULATED AND EXPERIMENTAL PROPANE MASS SPECTRA UPON ELECTRON VOLTAGE. Edward M. Eyring and Austin L. Wahrhaftig (Univ. of Utah, Salt Lake City). J. Chem. Phys., 34: 23-8(Jan. 1961).

Experimental propane mass spectra were obtained with bombarding electrons ranging in energy from 14 to 500 volts. The quasi-equilibrium theory was used in calculating the same spectra. The grossly simplified version of the statistical theory that satisfactorily predicts the 70-volt mass spectrum is inadequate at low voltages, but if half the theoretical number of oscillators are assumed to be effective in the parent-ion and activation energies that bear no simple relation to experimental appearance potentials are employed, a semiquantitative fit of the experimental data is obtained. The description of the decomposition reaction of a molecule-ion in terms of a collection of harmonic oscillators is clearly unsatisfactory. However, the more general form of the quasi-equilibrium theory, in which it is assumed only that the reaction coordinate is separable, does appear to be applicable. (auth)

11812 QUANTUM-MECHANICAL CELL MODEL OF THE LIQUID STATE. II. APPLICATION TO THE ZERO-POINT PROPERTIES OF CLOSE-PACKED CRYSTALS. R. P. Hurst and J. M. H. Levelt (Univ. of Wisconsin, Madison). J. Chem. Phys., 34: 54-63(Jan. 1961).

The quantum-mechanical cell model previously developed for liquids [J. M. H. Levelt and R. P. Hurst, J. Chem. Phys., 32: 96(1960)] is adapted and used to evaluate zero-point properties of the noble gases, H_2, and D_2. Specifically, this theory is applied to determine the heats of sublimation, the zero-point energies, and the equation of state for these gases at 0°K. By using the Lennard-Jones (6–12) intermolecular potential constants from second virial coefficient measurements as the only experimental parameters included in the theory, good agreement with the experimentally determined zero-point properties is generally obtained. (auth)

11813 ON THE LUMINESCENCE MINIMUM IN CERTAIN SCINTILLATOR SOLUTIONS. J. M. Nosworthy, John L. Magee, and M. Burton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 34: 83-9(Jan. 1961).

Several scintillator solutions were examined for the luminescence minimum previously reported for the case of Co^{60} γ-irradiated cyclohexane + benzene + p-terphenyl with oxygen present. The minimum is shown to be dependent on the nature of the solvents and of the quencher. A satisfactory interpretation of the data involves the notion of energy transfer from molecules of the less-efficient ("common") solvent to the molecules of the more efficient ("better") solvent and thence to the scintillator. The latter transfer appears to involve more than one molecule of the solvent.

A suggested model of the quenching process explains the existence of two classes of quenchers, one of which does not give a minimum. (auth)

11814 ON THE SOLUTION OF THE HARTREE-FOCK EQUATION IN TERMS OF LOCALIZED ORBITALS. William H. Adams (Univ. of Chicago). J. Chem. Phys., 34: 89-102(Jan. 1961).

The Hartree-Fock method is discussed with emphasis placed on the transformation properties of the Hartree-Fock equation. It is emphasized that the Hartree-Fock equation may be solved in terms of nonorthogonal one-electron functions, and that in some cases it may be more convenient to choose such solutions. Equations are developed which define the localized one-electron functions, and it is shown how these equations may be solved. For a system of closed shell atoms or ions, it is suggested that the localized orbitals of each atom or ion can be expanded in terms of functions centered on its nucleus. This suggestion is based on the success of the ionic theory of crystals. Due to the symmetry of a crystal, it is suggested that use of the localized orbitals could lead to expressions for the first order, Hartree-Fock density matrix and the Hartree-Fock energy of a crystal, i.e., one could obtain the solution of the Hartree-Fock equation for a crystal. (auth)

11815 SPIN-SPIN INTERACTIONS IN NUCLEAR MAGNETIC RESONANCE. CONTACT CONTRIBUTION. S. Alexander (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Phys., 34: 106-17(Jan. 1961).

A method for calculating the contact contribution to spin-spin interactions between nuclei in nonaromatic molecules is described. The method is based on the valence bond model. The equivalent hamiltonian of the Dirac vector model is used for a perturbation calculation in a representation where the total spin of the two electrons in each bond in the molecule is a good quantum number. The Ramsey-Purcell contact term in the interaction is calculated by a double perturbation method where only terms linear in the electron-nuclear interactions are considered but the perturbation is carried to higher order in the exchange integrals. In this way the interaction constants can be obtained explicitly in terms of the exchange integrals, and the calculation of the valence bond wave functions is avoided. It is then possible to see how the signs and magnitudes of the interaction constants depend on these integrals and what the dominant interaction mechanisms are. The perturbation series is evaluated explicitly with the electron nuclear contact interaction and the results are compared with the results of a similar calculation based on Ramsey's closure formula. In this way the objections against the closure procedure can be avoided. It is shown that Ramsey's formula can be used when different average energy separations are used for terms of different order in the expansion. The results of Ramsey for H_2 and of Karplus et al., for hydrogen atoms separated by two and three bonds and the justification of the method of calculation used by them are discussed in detail. It is found that only perturbation terms of one type are important in each of the cases discussed by these authors and therefore their procedure can be justified. The results previously obtained for spin-spin interactions in the allyl group are also discussed. (auth)

11816 EFFECT OF PRESSURE ON THE SPECTRA OF CRYSTALLINE UF_4 AND UF_3. K. B. Keating and H. G. Drickamer (Univ. of Illinois, Urbana). J. Chem. Phys., 34: 140-2(Jan. 1961).

The effect of pressure was measured on the crystalline spectra of UF_4 and UF_3. The UF_3, which has a structure analogous to PrF_3 and NdF_3, behaved much like those compounds, showing a 15 to 40% increase in intensity for different peaks in 50,000 atm. In UF_4 certain of the peaks increased in intensity while others decreased. The U^{4+} ion is almost at a center of symmetry in this crystal. It is indicated that the intensity behavior is reasonable if a significant fraction of the intensity is obtained due to lattice vibrations. Both red and blue shifts are observed on different peaks. (auth)

11817 EFFECT OF PRESSURE ON THE SPECTRA OF RARE EARTH IONS IN CRYSTALS. K. B. Keating and H. G. Drickamer (Univ. of Illinois, Urbana). J. Chem. Phys., 34: 143-51(Jan. 1961).

The effect of pressure to 180,000 atm was measured on the absorption spectra of crystalline rare-earth ions. The effects observed include: An increase of intensity due to increased mixing of 5d and 4f orbitals in the excited state due to an increase of the mixing potential with decreased interionic distance; Small shifts accompanied by increases in half-width. Except for the shifts of $^3P_0$, $^3P_1$, and $^3P_2$ levels of Pr^{3+}, these can be accounted for by an increase in the splitting of the individual levels due to intensification of the crystal field; and Changes in shape of several of the bands, possibly due to changes in occupation of the various states which make up the bands. (auth)

11818 SUM RULE FOR TRANSITION PROBABILITIES. William L. Clinton (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 34: 273-5(Jan. 1961).

A sum rule is derived for the spontaneous emission transition probability. In particular it is shown that for an atom $\sum_m^{\infty} W_{nm} = Z\rho_n(0)$, where W_{nm} is the spontaneous emission transition probability, Z is the nuclear charge, and $\rho_n(0)$ is the electron density of the nth electronic state evaluated at the nucleus. (auth)

11819 EMISSION SPECTRA OF TRIVALENT THULIUM. L. G. Van Uitert and R. R. Soden (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 34: 276-9(Jan. 1961).

Trivalent thulium can be caused to fluoresce selectively from different levels by choice of the wavelength of exciting radiation. This has made it possible to correct the assignments of emission transitions occurring in the visible range. As a consequence, the detailed data of Gobrecht were found to be in much closer agreement to the theoretical predictions than formerly realized. (auth)

11820 PARAMAGNETISM OF URANYL ION. EFFECT OF 6d ORBITALS AND Pi BONDING. R. Linn Belford (Univ. of Illinois, Urbana). J. Chem. Phys., 34: 318-21 (Jan. 1961).

Second-order perturbation calculations of the paramagnetism of OUO^{2+} ion were done. The contribution from π bonds may be considerable. Although a bonding scheme utilizing only the 6d and 7s orbitals of uranium could account for experimental values, some involvement of 5f orbitals is suggested. There is no clear-cut evidence for strong involvement of 5f orbitals in bonds. (auth)

11821 COLLISION-INDUCED DISSOCIATION OF HD^+. A. P. Irsa and L. Friedman (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 34: 330-1(Jan. 1961).

A mass spectrometric study of low-energy HD^+ ion dissociation is reported. He, Ne, and Ar were used as scattering gases at 10^{-5} mm Hg pressure, and product H^+ and D^+ yields of $\sim 10^{-12}$ amp were measured for collected HD currents of $\sim 10^{-9}$ amp. The transverse to forward velocity ratio u/v was found to be 0.0024 for 4.25-kev HD^+ ions, indicating a very narrow angular distribution of product ions.

This low u/v value is explained in terms of vibrational excitation of HD^+, and the explanation is extended to the problem of the discrepancy between the data of Sweetman and Federenko. A loss of 30% of the ion product up to the collector slit was found. Cross sections for dissociation of 4.25-kev HD^+ ions on collision with helium, neon, and argon are calculated to be 1.7, 2.14, and 2.5×10^{-16} cm^2, respectively. The result for helium agrees with the H_2^+, helium cross section of Federenko et al. (D.L.C.)

11822 DIPOLE MOMENT OF LITHIUM HYDRIDE. F. A. Matsen (Univ. of Texas, Austin). J. Chem. Phys., 34: 337-8(Jan. 1961).

The dipole moments of lithium hydride calculated in different ways are given: classical, ionic-covalent resonance, and ab initio quantum mechanics. It is pointed out that the eight ab initio four-electron calculations all agree with the experimental value within ±0.3 Debye. The disagreement of the calculated and experimental energies is discussed. (D.L.C.)

11823 STUDY OF THE ELECTRON-MOLECULE INTERACTION: ELECTRON TRANSITIONS INDUCED DURING COLLISION. J. C. Lorquet (Université, Liege). J. chim. phys., 57: 1078-84(Nov.-Dec. 1960). (In French)

The transition probabilities from the ground state of an isolated molecule to electronically excited states of the corresponding monopositive ion when the molecule is submitted to a bombardment of monoenergetic electrons are discussed. These transition probabilities are shown to be related to the ionization cross section. An empirical relation expressing the dependence of the latter quantities on the energy of the electronic transitions and on the acceleration voltage of the impinging electrons is then proposed. It is concluded that for a given energy of the bombarding electrons, the transition probability decreases regularly when levels more and more excited are considered. Transitions requiring 30 ev and more occur to a negligible extent, however energetic the impinging electrons may be. The mass spectra of small molecules (N_2, O_2, NO, CO, CO_2, and H_2O) are calculated by means of these relations, and a satisfactory agreement with experiment is found. (auth)

11824 MAGNETIC EFFECTS OF HIGH-ALTITUDE NUCLEAR DETONATIONS. A. M. Van Wijk (Hermanus Magnetic Observatory, Union of South Africa). J. Geophys. Research, 66: 647-8(Feb. 1961).

Two of the three Argus detonations produced noticeable effects on the magnetic traces at Hermanus (34° 25'S, 19° 14'E). The first detonation (Aug. 27, 1958) produced no effect; the two that did produce effects were those at 0.3:17.5 UT on Aug. 30 and 22:12.7 UT on Sept. 6, 1958. (D.L.C.)

11825 OPTIMIZATION OF A SANDWICHED THERMOELECTRIC DEVICE. B. W. Swanson, E. V. Somers, and R. R. Heikes (Westinghouse Research Labs., Pittsburgh). J. Heat Transfer, 83: 77-82(Feb. 1961).

An analysis is made for optimizing the thermal efficiency of a sandwiched thermoelectric device and is coded for a digital computer. For suitable input data, the computer determines the thermocouple design that approximately maximizes the thermal efficiency of the device. A verification of the analysis indicates that the difference between the approximately optimum efficiency and the optimum efficiency is negligible. (auth)

11826 THE ELECTRONIC STRUCTURE, SPECTRA, AND MAGNETIC PROPERTIES OF ACTINYL IONS. PART I. THE URANYL ION. S. P. McGlynn and J. K. Smith (Louisiana State Univ., Baton Rouge). J. Mol. Spectroscopy, 6: 164-87(Jan. 1961).

A calculation of the 1-electron MO energy levels of UO_2^{2+} has been carried out by using rough estimates of overlap integrals of a set of a Slater orbitals presumed to correspond to the relevant oxygen and uranium atomic orbitals. It is shown that the ground state of a weak uranyl ion is most probably $^1\Sigma_g^+$ and that the U–O bond order is three. It is suggested that the variation of the U–O bond length in the UO_2^{2+} entity and the decrease of the antisymmetric and symmetric vibrational stretching frequencies should condition a ligand spectrochemical series. A discussion of the spectrum of the uranyl ion is presented in terms of a Hund's coupling case (a) molecule. It is shown that the visible absorption band of the UO_2^{2+} ion most probably contains three distinct electronic transitions, which are the components of a $T \rightarrow S$ process. The lifetime of the emission process as calculated from the reverse absorption is 4.76×10^{-4} sec; as calculated by using a spin-orbital perturbation operator, it is of the order of 10^{-4} to 10^{-5} sec; the experimental value ranges from 10^{-4} to 7×10^{-4} sec. It is also shown that the transition is of an approximate charge-transfer type, and the use of the term "phosphorescence" for the emission process is advocated. Magnetic susceptibility and its anisotropy are also discussed. (auth)

11827 THE ELECTRONIC STRUCTURE, SPECTRA, AND MAGNETIC PROPERTIES OF ACTINYL IONS. PART II. NEPTUNYL, AND THE GROUND STATES OF OTHER ACTINYLS. S. P. McGlynn and J. K. Smith (Louisiana State Univ., Baton Rouge). J. Mol. Spectroscopy, 6: 188-98(Jan. 1961).

The ground state of the neptunyl ion is shown to be $^2\Phi_{(5/2)u}$ on the basis of magnetic susceptibility experiments and energy calculations which include spin-orbital coupling and ligand field effects. It is shown that the electronic spectrum of NpO_2^{2+} can be accounted for entirely by intra-5f-shell transitions. A low-energy infrared electronic transition in the range 2000 to 4000 cm^{-1} is predicted for the neptunyl ion but has not thus far been observed. The ground states, electron configurations, and magnetic susceptibilities of PuO_2^{2+}, NpO_2^+, AmO_2^{2+}, PuO_2^+, AmO_2^+, and UO_2^+ are also discussed. (auth)

11828 THE STATISTICAL THEORY OF NON-LINEAR FIELDS. J. P. Terletskii (Terletsky) (Moscow Univ.). J. phys. radium, 21: 771-5(Nov. 1960). (In French)

The canonical and microcanonical distributions of probabilities are introduced for an arbitrary classical, nonlinear field. The expressions of the functional density of probability of the lines of universe which give the particle-like solutions are found for the nonlinear field equations. The Feynmann formulation of quantum mechanics is only a special case of a general canonical distribution with an imaginary temperature. That temperature is interpreted as the statistical temperature of a thermostat constituted of particles having imaginary masses. The Planck constant is then a factor proportional to the temperature of the "imaginary" thermostat. (auth)

11829 NUCLEAR QUADRUPOLE RESONANCE UNDER HIGH PRESSURE. [PART] I. Tokujiro Fuke (Tokushima Univ., Japan). J. Phys. Soc. Japan, 16: 266-77(Feb. 1961). (In English)

The nuclear quardupole resonance frequencies of I^{127} in stannic tetraiodide (SnI_4), As^{75} in arsenolite (As_4O_6), Br^{81} in paradibromobenzene ($p\text{-}C_6H_4Br_2$) and in potassium bromate ($KBrO_3$) were measured as a function of hydrostatic pressure at various temperatures. The pressure range was 1 to 9000 kg/cm^2 in the temperature range from –77 to 100°C, and 1 to 1000 kg/cm^2 at liquid oxygen temperature, respectively. In general, the pressure and the

temperature dependence of the resonance frequency is found to agree with Bayer's theory incorporated with Kushida-Benedek-Bloembergen's theory. It is noticed, however, that an anisotropic change of the internal parameters for the positions of atoms in a unit cell would contribute appreciably to the analysis of the data even in the cases of cubic crystals, SnI_4 and As_4O_6, and that a deviation from the Bayer curve is observed in As_4O_6. Doublet lines for SnI_4 are found to behave differently as a function of volume, and it is concluded for the molecular crystal, As_4O_6, that the effective modes of lattice vibration which are responsible for the temperature dependence of the resonance frequency are intramolecular modes rather than a tipping mode of the molecule as a whole. (auth)

11830 A SIMPLIFIED CHROMATOGRAPHIC METHOD OF DETERMINING THE SURFACE AREA OF SOLID ABSORBENTS AND CATALYSTS. G. A. Gaziev, M. Y. Yanovskii, and V. V. Brazhnikov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 1: 548-52 (Nov.–Dec. 1960). (In Russian)

If the variation in heat of adsorption and entropy of a substance adsorbed on a column can be neglected, it can be shown from kinetic gas theory that $S_g = AV_g$, where A is a constant, S_g is the specific area of the adsorbent, and V_g is the specific volume of the occluded gas on the adsorbent. V_g can be determined from the maximum of the elution peak obtained during a gaseous chromatographic elution. A variety of substances such as corundum, ThO_2 calcined at 400 and 800°C, iron metal obtained by reduction of the oxide at 480 and 600°C, pumice stone, powdered silica gel, sulfonated charcoal, and various catalytic materials were subjected to chromatographic analysis, and it was found that the surface area varied linearly with the specific volume of the occluded gas over a range of surface areas from 1 to 100 m^2/g. The method is simple and rapid, since an independent determination of surface area (S_g) is made for some given adsorbent, and a plot of S_g vs. V_g is constructed for a given reagent that is eluted. Then a single determination of V_g for any other adsorbent gives the specific surface area of this adsorbent. The method can be used for the rapid determination of changes in the specific surface area of slurries or catalysts with time during operating conditions. (T.T.T.)

11831 COMPUTATION VARIANT OF PLAIN METAL APPLICATORS AND EXPERIMENTAL FOUNDATIONS THERETO. A. F. Bogoyavlenskiĭ and V. T. Belov. Med. Radiol., 5: No. 11, 67-71(Nov. 1960). (In Russian)

A formula is given for the computation of surface activity in radioactive applicators without determining the coefficient of radiation absorption by the material of the applicator. The use of the formula, though producing a somewhat larger error, does not require any preliminary complex measurements necessary while using the existing procedures. (auth)

11832 SOURCES OF POLARIZED IONS (FOR PROTONS AND SIMILAR PARTICLES). R. Fleischmann (Universität, Erlangen, Ger.). Nuclear Instr. & Methods, 11: 112-21 (Jan. 1961). (In English)

The possible methods for the production of polarized protons (or similar particles) are discussed. Probably the most promising schemes are: (1) To send a beam of atomic hydrogen through an inhomogeneous magnetic field (4- or 6-pol) and to separate one substate in a weak field; (2) to separate two substates commonly in a strong field. In this case 50% polarized protons can be obtained; (3) a radio-frequency transition between substates can be effected too. Then 75% polarized particles can be produced (but 100%, if every disturbance is avoided); and (4) setups similar to a Rabi apparatus should also give a 100% polarized atomic beam. A serious difficulty is the residual gas pressure in the ionization section, which is to be overcome by differential pumping and by the use of very strong atomic beams. Ionization yields are very small until now. Several other possible methods are discussed, and important aspects of apparatus built by several research groups are mentioned. (auth)

11833 CURRENTS FROM GAMMAS MAKE DETECTORS AND BATTERIES. Bernhard Gross and Preston Vincent Murphy (Instituto Nacional de Tecnologia, Rio de Janeiro). Nucleonics 19: No. 3, 86, 88-9(Mar. 1961).

The principles of detectors and batteries using Compton electrons derived from γ photons are reviewed. The current variation with γ energy for a detector with different absorber thicknesses is shown; the absorber thickness can be designed to give a response independent of photon energy or to discriminate against either low- or high-energy photons. (D.L.C.)

11834 NEUTRON-SOURCE CALIBRATIONS: A REVIEW. Edward J. Axton (National Physical Lab., Teddington, Eng.). Nucleonics 19: No. 3, 90, 92, 94(Mar. 1961).

A review is presented on neutron source calibrations by many laboratories throughout the world. The results of three recent comparison experiments are tabulated, for which a maximum absolute error of ±1.9% was found ($^1/_{10}$ of that of 10 years ago). The assumptions involved in the error derivation and comparison of dissimilar neutron sources are discussed. (D.L.C.)

11835 INTENSE Sb–Be SOURCES MAKE 10^{10} NEUTRONS/SEC. Edward J. Hennelly (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucleonics 19: No. 3, 124-5(Mar. 1961).

Antimony–beryllium sources offer a cheap way of obtaining intense neutron fluxes up to 10^{10} neutrons/sec and can be made in the following way: Antimony is irradiated in a reactor to form Sb^{124} and inserted into a beryllium cylinder, which emits neutrons by the γ,n reaction. Since Sb^{124} has a half life of 60 days, the source should be reactivated 2 or 3 times a year. The advantages of the source are that it is inexpensive, runs continuously, and gives off a nearly monoenergetic neutron beam at 25 kev similar to reactor thermal column fluxes. When separated from the beryllium, the antimony provides an intense γ radiation of 10^4 r/hr at 1 ft with a mean energy of 1.05 Mev. Other aspects of the source are treated, e.g., shielding and costs. (D.L.C.)

11836 HEAT FLUSH AND MOBILITY OF ELECTRIC CHARGES IN LIQUID HELIUM. II. TURBULENT FLOW. G. Careri, F. Scaramuzzi, and J. O. Thomson (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10), 18: 957-66(Dec. 1, 1960). (In English)

The effect of a counterflow of normal and superfluids in liquid helium (II) on a beam of ions across a wide channel was studied. When a critical value of the heat current was reached, a beam of negative ions was strongly affected. This was ascribed to turbulence in the superfluid component and to a strong interaction between the negative ions and the vorticity as vortex lines. The positive ions were almost unaffected. The different behavior of the two types of ions is discussed in terms of their structures. (auth)

11837 A METHOD FOR FASTER ANALYSIS OF BUBBLE CHAMBER PHOTOGRAPHS. P. V. C. Hough and B. W. Powell (CERN, Geneva). Nuovo cimento (10), 18: 1184-91(Dec. 16, 1960). (In English)

A measuring system is described which will enable photographs of bubble chambers to be measured at ~30 sec per event. The design is such that the system can be developed in the direction of automatic pattern recognition without needing an on-line computer. Current difficulties and specific lines of future development are also discussed. (auth)

11838 HOLE AND ELECTRON MOBILITIES IN DOPED SILICON FROM RADIOCHEMICAL AND CONDUCTIVITY MEASUREMENTS. Katherine B. Wolfstirn (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. and Chem. Solids, 16: 279-84(Nov. 1960). (In English)

Room-temperature (300°K) conductivity mobilities of holes and electrons in gallium-, arsenic-, and antimony-doped silicon have been calculated from electrical and radiochemical measurements by using the effective mass approximation. The concentration range investigated was from 10^{16} to 2×10^{18} cm^{-3} and from 4×10^{15} to 2.5×10^{19} cm^{-3} for p and n type silicon, respectively. Ionization energies from Hall effect measurements and their changes with concentration are estimated for the nondegenerate specimens. Ionization is assumed to be complete in the degenerate cases. In addition, the results are compared with published drift, conductivity, and Hall mobilities. (auth)

11839 SOLUTION OF THE FUNCTIONAL DIFFERENTIAL EQUATION FOR THE STATISTICAL EQUILIBRIUM OF A CRYSTAL. Robert M. Lewis and Joseph B. Keller (New York Univ., N. Y.). Phys. Rev., 121: 1022-37 (Feb. 15, 1961).

The s-particle distribution functions (s = 1,2,...) of classical equilibrium statistical mechanics are determined for a crystal, as power series in the temperature. They are obtained by solving Bogolyubov's functional differential equation. From the distribution functions, the thermodynamic functions of a crystal are computed as power series in the temperature. The leading terms in these series are the usual classical results which are customarily derived by assuming that the potential energy is a quadratic function of the particle displacements. The further terms, which depend upon the nonquadratic or anharmonic terms in the potential, provide corrections to the usual results, which become more important as the temperature increases. If only a few terms in the series are used, the results will be valid at temperatures low compared to some characteristic temperature of the crystal, e.g., the melting temperature. Since they are based on classical mechanics, the results are valid only at temperatures high compared to the Debye temperature. (auth)

11840 FRIEDEL SUM RULE FOR A SYSTEM OF INTERACTING ELECTRONS. J. S. Langer (Carnegie Inst. of Tech., Pittsburgh) and V. Ambegaokar. Phys. Rev., 121: 1090-2(Feb. 15, 1961).

The Friedel sum rule was derived for a system of interacting electrons in a periodic potential. (auth)

11841 NUCLEAR PARAMAGNETIC SUSCEPTIBILITY OF LOW-TEMPERATURE He^3 AND THE FLOW PROPERTIES OF SUPERFLUID SYSTEMS OF FERMIONS. Ronald M. Rockmore (Brandeis Univ., Waltham, Mass.). Phys. Rev. Letters, 6: 166-7(Feb. 15, 1961).

The magnetic susceptibility of He^3 as a possible test of a low-temperature phase transition in liquid He^3 to a highly correlated phase is calculated on the basis of the two-fluid model of superfluid many-fermion systems. It is concluded that the joint measurement of the moment of inertia of a cylindrical container of liquid He^3 and magnetic susceptibility determine the effective mass for flow in the asymmetric case. (D.L.C.)

11842 HYDRODYNAMICS OF HELIUM II IN ANNULAR GEOMETRY. P. J. Bendt and T. A. Oliphant (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters 6: 213-15 (Mar. 1, 1961).

The circulation of helium II in an annular geometry with a hypothetical velocity field is studied. The findings suggest that for helium II in a rotating cylinder, selective choice of the cylinder's angular velocity may produce persistent circulation of helium II for long periods of time after rotation of the cylinder is stopped. (T.F.H.)

11843 INFLUENCE OF SPIN IN ELECTRONIC TRANSFORMATIONS. K. A. Gschneidner, Jr., R. R. McDonald, and R. O. Elliott (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters 6: 218-20(Mar. 1, 1961).

Cerium undergoes a crystalline transformation at about 120°K and 1 atm, in which the crystal structure remains unchanged but the lattice constant is decreased. This transformation also occurs at room temperature at about 7500 atm. The effects on the transition temperature and pressure are studied when small amounts (2 at.%) of other rare-earth metals are added to cerium as solutes. It is found that the transition temperature depression is closely related to the number of unpaired $4f$ electrons in the solute atoms. The effect of the solute atoms on the pressure of the transformation at room temperature is found to be dependent only on the size of the solute atoms. (T.F.H.)

11844 LARGE ANISOTROPIC KNIGHT SHIFTS IN INTERMETALLIC COMPOUNDS. R. G. Barnes, W. H. Jones, Jr., and T. P. Graham (Iowa State Univ. of Science and Med., Ames). Phys. Rev. Letters 6: 221-3(Mar. 1, 1961). (IS-250)

Several intermetallic compounds are found to exhibit anisotropy on the Knight shifts of the nuclear magnetic resonances of component nuclei. An equation is derived for the line widths of the Knight shifts, and compounds with low quadrupole coupling such as $Ca(Al^{27})_2$, $Tm(Al^{27})_2$, $Yb(Al^{27})_2$, $Mg(Cu^{63})_2$, and $Mg(Cu^{65})_2$ are found to obey the derived equation; in compounds with high quadrupole coupling such as $La(Al^{27})_2$ and $Ce(Al^{27})_2$, the Knight shift is overridden by the quadrupole effect. (T.F.H.)

11845 EFFECT OF DILUTE SOLID SOLUTIONS OF IRON AND OF NICKEL ON THE NUCLEAR RESONANCE OF Co^{59}. Richard Conley La Force, S. Frederick Ravitz, and Gene F. Day (Univ. of California, Berkeley). Phys. Rev. Letters 6: 226-8(Mar. 1, 1961).

The nuclear resonance spectra of Co^{59} in solid solutions containing small amounts of iron or nickel are studied. It is proposed that the observed resonant frequencies of the solutions come about as a combination of effects: direct cobalt atom–solute atom interactions, spin polarization of conduction electrons by solute atoms, and stacking faults between coexistent hexagonal and face-centered cubic cobalt crystals. (T.F.H.)

11846 SOME EXPERIMENTAL ASPECTS OF THE FLOW PROPERTIES OF LIQUID HELIUM II. H. C. Kramers (Kamerlingh Onnes Laboratorium, Leiden). Physica, 26: Suppl., S81-8(Dec. 1960). (In English)

The two-fluid model for liquid helium and the possibility of the propagation of a wave of relative motion of the two fluids are discussed. An extension of this original theory by the kinetic theory of excitations of Landau and Khatalnikov is also described. Experiments on stationary flow through slits and capillaries are described. An explanation of the Gorter-Mellink natural friction is given in the theory

of quantized vortex lines. The existence of the lines was indirectly supported by the rotating bucket experiment and can give a suitable explanation of flow phenomena. (M.C.G.)

11847 FOREIGN PARTICLES IN LIQUID HELIUM II. G. Careri (Universitâ, Padua). Physica, 26: Suppl., S89-93(Dec. 1960). (In English)

The interactions of neutrons, He^3 atoms, and helium ions with liquid helium are discussed. The general theory of Placzek and Van Hove of inelastic scattering of cold neutrons by solid mediums was applied to liquid helium by Cohen and Feynman. Some results of this experiment are reviewed. The equilibrium and transport properties of the mixture of He^3 atoms with liquid helium were investigated. Studies of positive helium ions in liquid helium indicated that the positive ion is a droplet of polarized helium atoms around the charged one. (M.C.G.)

11848 RECENT ADVANCES IN THE THEORY OF SUPERCONDUCTIVITY. J. Robert Schrieffer (Univ. of Illinois, Urbana). Physica, 26: Suppl., S124-36(Dec. 1960). (In English)

The theory of superconductivity in which it is assumed that there is a net attractive interaction between pairs of "electrons" in time-reversed states, which give rise to a condensed state in which "electrons" near the Fermi surface are strongly correlated over distances of approximately 10^{-4} cm, is reviewed. The excitation modes and a generalized energy gap equation are discussed. A system of free fermions interacting via an effective two-body potential whose matrix elements are attractive for transitions in which both particles remain in the region about the Fermi surface but are repulsive otherwise is considered. The application of the independent quasi-particle approximation to a system of fermions interacting via strong short-range forces is also discussed. (M.C.G.)

11849 PERTURBATION THEORY OF ANTIFERROMAGNETISM. R. L. Mills, R. P. Kenan, and J. Korringa (Ohio State Univ., Columbus). Physica, 26: Suppl., S204-14(Dec. 1960). (In English)

An expansion in terms of connected diagrams was derived for the partition function of an antiferromagnetic spin system with isotropic exchange hamiltonian. It is shown that the series can be obtained as a perturbation over the Néel theory. A high-temperature perturbation expansion is suggested which is of similar structure but with the internal field being replaced by a purely imaginary quantity. The importance of summation methods is stressed in connection with the fact that the entire formalism is in configuration space. A method is indicated in which the thermodynamic energy plays a central role. (auth)

11850 FERROMAGNETIC SPIN WAVES. R. Brout. Physica, 26: Suppl., S215-17(Dec. 1960). (In English)

At low temperatures a Heisenberg model of a ferromagnet has for its elementary excitations the spin waves of Bloch. The nature of the collective oscillations at finite T was investigated. The theory predicted that the spin wave frequencies scale with temperature to lower values in proportion to the magnetism. Results were in agreement with the spherical model. At low T, a deviation from spin wave theory in T^3 was obtained. (M.C.G.)

11851 ANGULAR DEPENDENCE OF NUCLEAR SPIN–LATTICE RELAXATION TIME FOR SEVERAL ALKALI HALIDE CRYSTALS. E. R. Andrew, K. M. Swanson, and B. R. Williams (University Coll., North Wales, Bangor, Wales). Proc. Phys. Soc. (London), 77: 36-48(Jan. 1, 1961).

The anisotropy of relaxation time for both F^{19} and Li^7 was examined in a pure single crystal of lithium fluoride and was satisfactorily accounted for in terms of Bloembergen's spin-diffusion theory of relaxation. Confirmation was provided by the reduced anisotropy observed in two single crystals of lithium fluoride containing enhanced concentrations (50 and 90%) of Li^6. The lack of anisotropy of the Na^{23} relaxation time found in sodium chloride was in accord with the predictions of the theories of quadrupolar relaxation. A similar observation for the Br^{79} and Br^{81} relaxation times in potassium bromide was not inconsistent with van Kranendonk's theory and suggested that covalency does not make a strong contribution to the quadrupolar relaxation process. (auth)

11852 EXPLANATION OF SOME 'FORBIDDEN' TRANSITIONS IN PARAMAGNETIC RESONANCE. B. Bleaney and R. S. Rubins (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 77: 103-12(Jan. 1, 1961).

The abnormal intensity of some "forbidden" hyperfine transitions in the paramagnetic resonance spectra of ions with S = 1 or more is shown to be due to cross terms in the spin hamiltonian. These arise from off-diagonal terms in the electronic and nuclear interactions, and the computed transition intensities agree closely with measurements on vanadium fluosilicate. In a powder an apparent doubling of the hyperfine transitions is shown to be due to the combined effect of these terms and others due solely to the electronic splitting. (auth)

11853 QUADRUPOLE-QUADRUPOLE INTERACTION IN THE RARE EARTHS. B. Bleaney (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 77: 113-15(Jan. 1, 1961).

The interaction specific heat of the spin system of cerium ethyl sulfate when only the lowest doublet is populated was found by Cooke, Whitley, and Wolf to be about 6 times that expected for magnetic dipole interaction alone. The extra interaction was attributed to electric quadrupole-quadrupole (EQ) interaction. The theory of Finkelstein and Mencher, which postulates that the interaction between two ions each in the ground doublet is a second-order effect of the EQ interaction and which results in a pair of ions, one in the X^+ state and the other in the X^- state, having a slightly different energy from a pair that are both in the same state was investigated. Results suggested that not all of the excess interaction observed below 1°K can be attributed to EQ interaction. The excess interaction might be partly or wholly due to exchange interaction. (M.C.G.)

11854 LOCAL PROPERTIES IN NON-EQUILIBRIUM SYSTEMS. J. M. Blatt (Kyoto Univ. and Univ. of New South Wales, Sydney). Progr. Theoret. Phys. (Kyoto), 24: 741-54(Oct. 1960). (In English)

The development of a satisfactory statistical mechanics for nonequilibrium states was retarded by the difficulty of making a satisfactory definition of "local temperature," that is, a definition which does not depend on the very restrictive assumption of local equilibrium. For any subvolume ΔV of the system, the "local statistical operator" $W(\Delta V)$, which can be deduced directly from the statistical operator (density matrix) U of the system as a whole, is defined. Local entropy $S(\Delta V)$ and a local energy $E(\Delta V)$ are also defined. A new requirement for the macroscopic independent variables which define the macroscopic state of the system was introduced: such variables must be directly deducible from a knowledge of the present state (density matrix) of the system, without reference to its future time development i.e., without reference to its Hamiltonian H. Of any pair of thermodynamically conjugate variables, at most one is permissible in the light of this requirement. In particular, volume, particle numbers, and entropy are permissible macroscopic independent variables; pressure,

chemical potential, and temperature are not. These latter are permissible as dependent variables only unless the system happens to be in equilibrium. (auth)

11855 THE MEISSNER EFFECT IN THE QUASI-CHEMICAL EQUILIBRIUM THEORY OF SUPERCONDUCTIVITY. J. M. Blatt (Univ. of New South Wales, Kensington). Progr. Theoret. Phys. (Kyoto), 24: 851-76(Oct. 1960). (In English)

Based on the quasi-chemical equilibrium theory of superconductivity, an explicitly gage-invariant proof of the Meissner-Ochsenfeld effect (magnetic field expulsion from a superconductor) is given. The essential condition for a Meissner effect is the Bose-Einstein condensation of electron pairs. Other aspects of the problem, such as the energy gap and plasma waves, are not necessary for the Meissner effect and do not appear in the calculation. The random-phase approximation was not used. (auth)

11856 A NOTE ON EXCITON MULTIPLICITIES. R. S. Knox (Argonne National Lab., Ill.). Progr. Theoret. Phys. (Kyoto), 24: 909-10(Oct. 1960). (In English)

A case in which a singlet exciton state lies below a triplet state is discussed with reference to Takeuti's position that such a case would be a violation of Hund's Rule. (M.C.G.)

11857 STUDIES ON NUCLEAR EMULSIONS WITH POLYVINYL ALCOHOL. I. PREPARATION AND PROPERTIES OF PVA NUCLEAR EMULSIONS FOR PARTICLE-TRACK RESEARCH. Etsuo Fujii. Tokyo Kogyo Shikensho Hōkoku, 56: 3-4(Jan. 1961). (In English)

Neutral and ammoniacal silver bromide emulsions with polyvinyl alcohol as protective colloid were prepared on glass plates, and their properties were studied. Tracks of α particles and protons form in these emulsions without fog increase, the former being located very close to the surface. The average track length is 33 μ for α particles and 400 μ for protons. Granular or clumping particles, which were attributed to collective radiation effects, were found in irradiated emulsions near the emulsion-glass interface. Hypersensitization by 6% triethanolamine solution was successful, whereas heating or gold chloride addition resulted in fog increase. However, 6-nitrobenzimidazole was found to reduce fog. Fading of latent α tracks was negligible, even for development 30 days after exposure. Directional α tracks can be detected using emulsions spread on a cylinder. (D.L.C.)

11858 ON THE OSCILLATION OF ELECTRONS IN HYPERBOLIC MAGNETIC FIELDS AND ITS APPLICATION TO MICROWAVE GENERATION. H. Alfvén, S. Berneryd, T. Hanaas, L. Lindberg, and E. Åström (Royal Inst. of Tech., Stockholm). Trans. Roy. Inst. Technol. Stockholm, No. 167, 1-92(1960). (In English)

The oscillation of electrons in a magnetic field of hyperbolic character was studied theoretically with special attention given to the stability of the motion. The results were utilized for the construction of a new kind of microwave generator, called the "meander tube." Tubes oscillating at 3×10^9 cycles/sec are described. The general properties were studied on a model tube, and the results are discussed. (auth)

11859 INVESTIGATION OF THE THERMAL STRUCTURE OF HELIUM II WITH THE HELP OF THE SCATTERING OF COLD NEUTRONS. E. L. Andronikashvili. Uspekhi Fiz. Nauk, 72: 697-710(Dec. 1960). (In Russian)

In the basis for current descriptions of the behavior of helium II lies the idea of the existence of two fundamental types of quantum thermal excitations, called phonons and rotons. A series of investigations in which the scattering of cold neutrons in liquid helium is interpreted in terms of scattering events in which a phonon or roton is created and takes up the recoil momentum is surveyed. Correlation of the neutron's energy and momentum changes occurring in the event yields a dispersion curve relating the energy and momentum of the thermal excitations. The experimental techniques and the analysis and interpretation of data are outlined. The results reproduce quite well a segment of the dispersion curve predicted by Landau. The high-momentum end of the curve (beyond the range of existing data) and its interpretation in terms of various possible forms of the behavior of unstable rotons is discussed. The possibility of the direct determination of the roton's chirality from the forward scattering cross section is discussed. Finally the temperature dependence of a series of thermodynamic functions predicted using an experimental dispersion curve is presented. The resulting curves agree remarkably well with direct measurements, except for a low-temperature discrepancy in the velocity of second sound. (TTT)

11860 SURFACE IONIZATION OF CESIUM IN DIFFUSION THROUGH POROUS TUNGSTEN. Yu. Ya. Stavisskiĭ and S. Ya. Lebedev. Zhur. Tekh. Fiz., 30: 1222-6(Oct. 1960). (In Russian)

The ion current from the ionizing surface (porous emitter) is investigated as a function of the surface temperature with constant cesium vapor discharge. The design of the device used in the experiment is described, and the distribution of the emitter thermocouple and the curves of ion current as a function of various temperatures are plotted. At certain temperatures a complete surface ionization was observed during cesium vapor diffusion through porous tungsten. The saturation temperature is higher with smooth emitters; at a current density of 10 $\mu a/cm^2$, the temperature shift is ~80°C; and at 0.25 $\mu a/cm^2$ it is ~50°C. (R.V.J.)

11861 PROCEEDINGS [OF] 14th ANNUAL POWER SOURCES CONFERENCE, 17-18-19 MAY 1960. Red Bank, N. J., PSC Publications Committee. [1960]. 156p. (NP-9765)

Papers are included which were presented at the 14th Annual Power Sources Conference in Fort Monmouth, N. J. The topics include thermal- and solar-energy conversion, batteries, comparison of energy conversion systems, and energy storage devices. Separate abstracts were prepared for six papers. (D.L.C.)

11862 MATERIALS FOR THERMOELECTRIC CONVERSION. R. F. Redemske (Servo Mechanisms, Inc., [Goleta, Calif.]). p.4-7 of "Proceedings [of] 14th Annual Power Sources Conference, 17-18-19 May 1960." Red Bank, N. J., PSC Publications Committee. [1960].

The influence of materials on the thermoelectric-cell efficiency and ways of improving this influence are discussed. The material should be selected to maximize the figure of merit Z. General rules for the selection of thermoelectric materials are given. The plots of Z vs. absolute temperature T show that the Z maxima of the different materials and doping levels form a curve approximately defined by $ZT = 1$, which appears to impose an upper limit on the performance of thermoelectric materials. The efficiency was calculated for a constant cold-junction temperature of 300°K with a continuously upgraded material with Z at a maximum all along the material length and plotted vs. the hot-junction temperature; it reaches 20% at 1500°K. (D.L.C.)

11863 NUCLEAR ENERGY POWER SOURCES. George H. Ogburn, Jr. (U. S. Atomic Energy Commission, Wash-

ington, D. C.). p.12-18 of "Proceedings [of] 14th Annual Power Sources Conference, 17-18-19 May 1960." Red Bank, N. J., PSC Publications Committee. [1960].

The applications of small light-weight nuclear power sources for operation without maintenance for long periods of time in remote areas are discussed. Such sources cost and weigh less than conventional chemical batteries. The SNAP program, which is developing several devices under 1 kw(e) output, is described. SNAP 10 is a reactor energy source giving 0.3 Mw(e) output from U^{235}–Zr hydride fuel and is a static, compact unit with no cooling system. Some of the possible isotopes for use in radioisotopic energy sources and their characteristics are given. SNAP III is fueled by Po^{210}, whereas SNAP 1A is fueled by Ce^{144} and is designed for use in space. Other radioisotopic units being developed are briefly described, e.g., thermionic units and units utilizing a long-lived radioisotope (Sr^{90}). (D.L.C.)

11864 PHOTOELECTRIC CONVERSION. Arthur S. Jensen and Igor Limansky (Westinghouse Electric Corp., Pittsburgh). p.46-9 of "Proceedings [of] 14th Annual Power Sources Conference, 17-18-19 May 1960." Red Bank, N. J., PSC Publications Committee. [1960].

Photoelectric conversion as a method of utilizing solar energy is treated in detail. Analysis of the photoelectric effect shows that close spacing of the cathode and anode, low work function for the anode, and screening the anode to keep it in the dark can be used to make a low-impedance generator with useful efficiency. Utilization of the solar spectrum by photogenerators with antimony-cesium photocathodes is examined; a photogenerator with a spacing on the order of 2 mils should be illumination-limited and unaffected by space charge. The practical aspects of photogenerator design are next considered, and performance curves are presented for the WX-3964 photogenerator. Photogenerators have the advantages of simple design and low specific weight and can be fabricated in balloon shape for use as space power sources. (D.L.C.)

11865 COMPARISON OF ENERGY CONVERSION SYSTEMS. J. H. Fisher and W. R. Menetrey (Electro-Optical Systems, Inc., [Pasadena, Calif.]). p.94-6 of "Proceedings [of] 14th Annual Power Sources Conference, 17-18-19 May 1960." Red Bank, N. J., PSC Publications Committee. [1960].

A comparison was made of various energy conversion systems (batteries, fuel cells, nuclear- and solar-energy sources, etc.) on the basis of space satellite power requirements. Only nuclear- and solar-energy sources can meet these requirements over long periods of time, and all the possible combinations of conventional energy forms (thermal or electric) and conversion techniques (heat engines, photovoltaic cells, thermionic converters, etc.) with nuclear- and solar-energy sources were evaluated with respect to reliability, weight, availability, growth potential, cost, hazard, and life for 5- and 30-kw systems. The weighted evaluations show that no single system is outstandingly superior or inferior and that choice of a system should be made on the basis of its development. However, the solar Stirling engine and nuclear thermionic systems appear to be desirable for use as 5- and 30-kw systems, respectively. (D.L.C.)

11866 STORAGE OF RADIANT ENERGY SOLIDS. H. P. Kallmann (New York Univ., New York). p.100-7 of "Proceedings [of] 14th Annual Power Sources Conference, 17-18-19 May 1960." Red Bank, N. J., PSC Publications Committee. [1960].

Energy storage can be used for power and information purposes, and the general methods of converting radiant energy into storageable form are reviewed. The storage processes in solids, their efficiencies, and release mechanisms are also reviewed. Several processes are considered in detail: absorption of ultraviolet light by alkali trimethyl methide in glass, producing free radicals; dissociation of H_2O by ultraviolet light; illumination of organic material between electrolytic electrodes; and persistent internal polarization. The application of the latter process to storage and release of information is shown. (D.L.C.)

11867 APPARATUS FOR EXPOSING SHEET MATERIAL TO RADIATION. (to Minnesota Mining and Manufacturing Co.). British Patent 860,437. Feb. 8, 1961.

A semiautomatic apparatus is described for exposing sheet materials to radiation. The apparatus comprises a cylindrical support for a sheet and a radiation source; in operation, the support is rotated near the radiation source so that the sheet is progressively irradiated from edge to edge. The support means is designed so that the sheet is supported at its edges without pressure on its area. Its electric control circuit is also discussed. The apparatus should be useful for the fusion of a rough thermoplastic coating into a smooth layer and treatment of inked heat-expandable sheets to give high, graduated relief patterns. (D.L.C.)

11868 IMPROVEMENTS RELATING TO SHOCK ABSORBING DEVICES. John George Morland and George Camac (to AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 860,691. Feb. 8, 1961.

A shock absorber is designed for absorbing a longitudinal impact shock at the end of a body, e.g., a reactor control rod. The absorber comprises a buffer member with one end projecting through the body and a tapered member attached to the other end. In operation, when an impact shock is applied to the other end of the buffer, shear pins are fractured, and the tapered member is forced upward past cutters that absorb the impact energy by reason of its cutting action. (D.L.C.)

Astrophysics and Cosmology

11869 (NASA-TN-D-487) THE SOLAR WIND. J. R. Herring and A. L. Licht (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Sept. 1960. 16p.

Parker's model of a spherically expanding corona, the "solar wind," was compared with D. E. Blackwell's observations of the 1954 minimum equatorial corona. A significant discrepancy was found between the predicted and the observed electron densities at distances from the sun greater than 20 solar radii. Blackwell's data were found to be consistent with a model in which the corona expands mostly within a disk less than 25 solar radii thick, lying within the sun's equatorial plane. The thickness of the disk as a function of distance from the sun is qualitatively explained in terms of magnetic pressure. The solar wind was found to have a considerable effect on the lunar atmosphere. First, the calculated density of the lunar atmosphere is greatly reduced by collisions with protons in the solar wind. If the flux of particles in this wind has the conventional values ranging between 10^{10} to 10^{11} cm^2/sec, the calculations yield a lunar pressure of 10^{-13} atmosphere of argon, in agreement with the value predicted by Elsmore and Whitfield on the basis of observations on the occultation of radio stars. Second, following a suggestion by Gold, it was found that the collisions of solar-wind protons with the lunar surface produce an atmosphere of cold neutral hydro-

gen with a density of $10^5/cm^3$ at the lunar surface. The density falls off at greater distances in accordance with the inverse-square law. Estimates indicated that the interaction of solar particles with the neutral hydrogen will produce an extended lunar ionosphere with a density of the order of 400 protons/cm^3 in the vicinity of the moon. (auth)

11870 (CEA-tr-A-820) NOUVELLE DÉTERMINATION DU TAUX DE DÉSINTÉGRATION TERRESTRE ET NATUREL DU TRITIUM. ORIGINE DU TRITIUM "NATUREL." (New Determination of Rates of Disintegration of Terrestrial and Natural Tritium. Origin of Natural Tritium). F. Begemann. Translated into French from Z. Naturforsch. 14A: 334-42(1959). 38p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 13819.

11871 (JPRS-4365) RECENT ACHIEVEMENTS IN METEORITICS. V. G. Fesenkov. Translated from Meteoritika, 18: 5-16(1960). 18p.

A review is given of investigations of isotopic content of various elements found in meteorites, and the results of the age determinations of the meteorites. 44 references. (JPRS)

11872 ON A POSSIBLE MECHANISM OF SOLAR NONSTABLE PROCESSES LEADING TO NEUTRON ERUPTIONS. V. A. Petukhov (Joint Inst. for Nuclear Research, U.S.S.R.). Ann. géophys., 14: 425-32(Oct./Dec. 1958). (In English)

The neutron hypothesis leads to a reasonable explanation for the direction of the corpuscular flux ejected from the active regions of the sun. The question of the possibility of a generation of neutrons on the sun is the consequence of a wider class of phenomena connected with general solar nonstability. It is shown that the formation of a nucleus with increased lithium concentration in the internal parts of the sun in the process of its evolution may be the initial cause of nonstable processes of all kinds and, in particular, the formation of sunspots. Free neutron decay will make it possible to account for the presence of hard x rays in the composition of solar radiation. As it follows from the considered mechanism of intersolar mass ejection, the axis of the corpuscular flux may not coincide with the radial direction; as a result, the corpuscular velocities usually calculated by the lag of terrestrial phenomena are low and must be reconsidered. (auth)

11873 GEOPHYSICAL EFFECTS OF SOLAR CORPUSCULAR RADIATION. S. F. Singer (Maryland. Univ., College Park). Ann. géophys., 14: 433-7(Oct./Dec. 1958). (In English)

Magnetic storms, auroras, and cosmic-ray variations are explained from a unified theoretical point of view. The sudden commencement of magnetic storms seems to be due to ionospheric currents initiated by solar corpuscular radiation. The main phase of storms is explained in terms of an extra terrestrial ring current set up by the drifting motion of trapped solar particles. These trapped particles are also accelerated to high enough energies to cause aurora; the acceleration proceeds mainly by Fermi collisions with magnetohydrodynamic waves (which give rise to geomagnetic micropulsations). Decreases in cosmic-ray intensity, which accompany magnetic storms, are produced by a diffusive deceleration process in interplanetary space. (auth)

11874 A SERIES OF SUBDWARF ATMOSPHERES. Thomas L. Swihart and David Fischel (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., 5: No. 49, Suppl. Ser., 291-380(Jan.1961).

A series of model stellar atmospheres, representing stars of low heavy-element content, is tabulated. Characteristics of the continua of the models, including (U, B, V) colors and bolometric corrections, are discussed and compared with observations. (auth)

11875 ABUNDANCES IN G DWARF STARS. IV. A REDETERMINATION OF THE ABUNDANCES IN G DWARFS IN THE HYADES. Robert Parker (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena), Jesse L. Greenstein, H. L. Helfer, and George Wallerstein. Astrophys. J., 133: 101-6(Jan. 1961).

A redetermination of the abundances of Na, Mg, Si, Ca, Sc, Ti, Cr, Mn, Fe, Ni, and Ba in G dwarfs in the Hyades was carried out. The method was the same as that used in a previous determination (Wallerstein and Helfer 1959), but with new material at higher dispersion and with a different telescope and spectrograph. Another star of temperature even closer to that of the sun is included. The conclusions of the previous study are confirmed and strengthened; there appears to be a small and possibly significant general enrichment of the metals by approximately 20% in the Hyades stars when compared with the sun. Barium is again found to be overabundant by approximately a factor of 2. (auth)

11876 MODELS OF MASSIVE PURE HYDROGEN STARS. Dilhan Ezer (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Astrophys. J. 133: 159-65(Jan. 1961).

If the earth's galaxy was initially composed of pure hydrogen, then the first stages of element formation would take place in massive stars condensing from such a medium. "Main-sequence" models were constructed for pure hydrogen stars ranging in mass from 1 to 2000 solar masses. It was found that there is a remarkably high average density in such models and that convection takes place in their cores. However, most of the models are purely formal ones, since appreciable helium formation takes place before such stars have fully contracted toward the main sequence. In stars of mass greater than about 26 solar masses, sufficient C^{12} will form from this initial helium to alter the main-sequence structure through energy generation by the carbon cycle. (auth)

11877 ON INHOMOGENEOUS STELLAR ATMOSPHERES. I. W. Busbridge (St. Hugh's Coll., Oxford). Astrophys. J., 133: 198-209(Jan. 1961).

The problem of a plane parallel stellar atmosphere is discussed in which there is isotropic scattering at any given optical depth but in which the albedo for single scattering varies with the optical depth. The general solution for the emergent intensity, when the upper and lower surfaces of the atmosphere are subject to known incident radiation, is shown to depend on the solutions of two independent problems: that in which the atmosphere has a fixed lower surface free from incident radiation and a variable upper surface on which radiation is incident at a fixed angle with the normal, and that in which the roles of the lower and upper surfaces are interchanged. The work of V. V. Sobolev and S. Ueno is discussed. (auth)

11878 ACCURATE PARTITION FUNCTIONS IN THE DETERMINATION OF THE C_2 ABUNDANCE. Enrico Clementi (Univ. of California, Berkeley). Astrophys. J., 133: 303-8(Jan. 1961).

Recent theoretical and experimental data on the diatomic carbon molecule make feasible an accurate calculation of the partition function at high temperatures. All the excited states which contribute to the partition function were considered. A table of thermodynamic functions in the tem-

perature range 2000 to 6000°K is given. The results so obtained are used in the recalculation of the molecular abundance, S, as defined by Russell, Roach, and Hunaerts. In the solar reversing layer the molecular abundance was found to be log S = 12.83. The rotational lines of the 0–0 band in the Swan system are used to obtain the molecular abundance. The oscillator strength of the Swan system was taken as f = 0.04 and the molecular excitation temperature as T = 4500°K. The results indicate the importance of accurate partition-function calculations in the determination of the molecular abundance. (auth)

11879 THE ABUNDANCE OF LITHIUM IN T TAURI STARS: FURTHER OBSERVATIONS. Walter K. Bonsack (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., 133: 340-3(Jan. 1961).

Spectra are reported for ten T Tauri stars (mainly in the Taurus and Orion nebulosities) in the region of the lithium I doublet at 6708 A. The permitted and forbidden transitions in the emission spectra, absorption lines, and the depth of the lithium I doublet, as compared with that of three nearby strong features (mostly Fe I) are tabulated for these stars. All the stars show high lithium abundances, and it is predicted that all T Tauri stars within a few parsecs of the sun have high lithium abundances. (D.L.C.)

11880 RECENT IMPROVEMENT IN OUR KNOWLEDGE OF COSMIC ABUNDANCES. William D. Ehmann (Univ. of Kentucky, Lexington). J. Chem. Educ., 38: 53-7(Feb. 1961).

Experimental cosmic abundance data since 1956 are reviewed with emphasis on data from refined analyses of chondritic meteorites. Data on iron and stony-iron meteorites since 1956 are also included. In the Z = 3 to 29 range the values except for lithium are in reasonably good agreement with those of Suess and Urey (1956). For Z = 32 to 71 serious discrepancies exist between the new data and the values of Suess and Urey for Z = 35 and Z = 54. There is a large difference in barium abundance for chondrite falls and finds. The new value for indium is 100 times lower, and the rare-earth values are lower. At Z = 74 to 92, the elements mercury, thallium, lead, and bismuth all have much lower abundances than can be explained by current element synthesis theories. A new Th^{232}/U^{238} value of 3.3 is offered. 49 references. (T.R.H.)

11881 THE CHEMISTRY OF CREATION OF THE HEAVY ELEMENTS. Charles D. Coryell (Massachusetts Inst. of Tech., Cambridge). J. Chem. Educ., 38: 67-72 (Feb. 1961).

The process is outlined by which the elements were formed; the treatment is limited to elements above Z = 70. The process is that of very rapid capture of fast neutrons in a supernova explosion whereby atoms in the iron region (where nuclear binding is tightest) suddenly are exposed to a tremendous flux of fast neutrons of short duration, and hundreds of neutrons may be captured. Subsequent radioactive decay gives us the elements we now know. This mechanism is supported by data on nuclear shell structure, astronuclear reactions, isotopic abundances, and abundance peaks and shell numbers. 21 references. (T.R.H.)

11882 CHRONOLOGY OF NUCLEOSYNTHESIS AND EXTINCT NATURAL RADIOACTIVITY. Truman P. Kohman (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Educ., 38: 73-82(Feb. 1961).

A review is presented on the age of the earth's elements and the time dependence of element synthesis within the time span in which our elements were formed. The discussion deals first with general ideas on the time of nucleosynthesis, then moves on to discuss the termination date of nucleosynthesis in which the decay interval for extinct I^{129} and the age of meteorites are cited. Calculations of the duration of nucleosynthesis are made and compared with those of Fowler and Hoyle. The generation of radiogenic heat is next considered as it relates to the continuous, single-event, and mixed nucleosynthesis mechanisms. The treatment concludes with consideration of the time dependence of nucleogenesis and other cases of extinct natural radioactivity. 67 references. (T.R.H.)

11883 OBSERVATIONAL TESTS IN COSMOLOGY. F. Hoyle. Proc. Phys. Soc. (London), 77: 1-16(Jan. 1, 1961).

Cosmologies separate sharply into those which predict that a definite origin of the whole universe occurred a precise finite time ago and those which require no such origin to have taken place. Observational methods exist for arriving at a decision between these two forms of theory. Proposed differences between the present state of the universe (determined by the observer's immediate locality) and the past condition of the universe (determined by observation of very distant objects) are investigated under the heading of geometrical tests. The past history of the universe must have been such as to lead to the present state. When applied to the formation of galaxies, the ages of galaxies, the generation of cosmic rays, and cosmic radio waves, the local evolutionary has far-reaching implications. The current status of these two types of tests is reviewed. (auth)

11884 ON ANTIMATTER AND COSMOLOGY. C. J. Kevane (Arizona State Univ., Tempe). Science, 133: 580-1 (Feb. 24, 1961).

A cosmological model, based on a gravitational plasma of matter and antimatter, is discussed. The antigravitational interaction of matter and antimatter leads to segregation and an expansion of the plasma universe. The expansion time scale is controlled by the aggregation time scale. (auth)

Cosmic Radiation

11885 (AD-240811) SOME CONSIDERATIONS OF EXPECTED RADIATION BELTS OF PLANETS MARS AND VENUS. Presented at 6th National Annual Meeting American Astronautical Society 18-21 January 1960 [held at] New York City. S. F. Singer (Maryland. Univ., College Park). 16p. Contract AF19(604)5575.

The historical development of the ideas which led to the prediction of geomagnetically trapped radiation is briefly traced out. Direct observations are summarized, and various theories concerning the origin of the radiation belts are discussed. The neutron albedo-plus-solar injection theory (which predicts existence of two belts) is then applied to calculate the expected distribution of trapped particles near Mars and Venus. The "sweeping" effect of the Martian satellite Phobos is calculated; it should provide a radiation-free base near Mars. (auth)

11886 (AFMDC-TN-60-12) AIRBORNE DETECTION AND ANALYSIS OF PRIMARY COSMIC PARTICLES WITH A SCINTILLATION DEVICE. dePaul J. Corkhill and Rudolf A. Hoffman (Air Force Missile Development Center, Holloman AFB, N. Mex.). July 5, 1960. 16p. (AD-242202)

Data are presented as derived from telemetered information from a primary cosmic-particle detecting device. The data are preliminary in nature in that comparison between the cosmic-particle spectrum (as shown by the mechanical detector) was not made with similar information provided by nuclear emulsions exposed to regions of pri-

mary cosmic particles simultaneously with the mechanical device. (auth)

11887 (CEA-tr-R-1067) ORIGINE DES RAYONS COSMIQUES. (Origin of Cosmic Rays). V. L. Ginsburg (Guinsburg) and M. I. Fradkin. Translated into French by B. Vinogradoff from Priroda, No. 8: 3-12(1958). 28p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 322.

11888 (JPRS-7488) DISTRIBUTION OF ENERGY IN THE SPECTRUM OF SOLAR RAYS AT VARIOUS ALTITUDES. L. A. Biryukova. Translated from Trudy Tsentral. Aerolog. Observatorii, No. 25, 72-6(1959). 9p.

Computations were made for solar radiations for the relation $p/p_0 = 1, 0.25, 0.13, 0.06, 0.04$, and 0.02, where p_0 was the air pressure at the earth's surface, and p was the air pressure at 0, 10, 15, 20, 25, and 30 km. In the computations for wavelengths of 0.29 to 5.00 μ, the ozone absorption of solar radiation in the Hartley-Huygens and the Chappuis bands was considered. The tabulated results indicate that there is a 2.42-mm ozone equivalent contained in the 0 to 70-km layer of atmosphere and comprises 96.4% of the total. The solar radiation computations were made for solar altitudes of 90, 30, 19.3, and 14.3°, which roughly corresponds to atmospheric masses equal to 1, 2, 3, and 4 related to the terrestrial surface. The computational results are tabulated and graphed and compared with previous results. (B.O.G.)

11889 ON THE DENSITY SPECTRUM OF ELECTRON-PHOTON COMPONENT OF EXTENSIVE AIR SHOWERS OF COSMIC RADIATION. J. Massalski and L. Turek (Inst. of Nuclear Research, Krakow). Acta Phys. Polon., 19: 637-45 (1960). (In English)

Measurements of the exponent of the density spectrum for the electron-photon component of the extensive air showers of cosmic radiation were made by means of a 48-channel hodoscope connected with 6 counter sets. The results obtained show that within the limits of experimental error the exponent does not vary with the thickness of a lead absorber (in the range 0 to 27 mm). (auth)

11890 SOME GEOPHYSICAL ASPECTS OF COSMIC RAYS. Arne Eld Sandström (Uppsala Univ.). Am. J. Phys., 29: 187-97(Mar. 1961).

Primary and secondary cosmic radiation intensity variations resulting from atmospheric effects are discussed. The normal effect of the terrestrial magnetic field on the primary cosmic-ray particles is considered. Intensity variations (Forbush decreases) correlated to magnetic storms (sudden commencements) was also studied. Daily intensity variations and an experiment during the IGY on the diurnal variation of the cosmic rays are outlined. (auth)

11891 SYMPOSIUM ON ASTRONOMICAL ASPECTS OF COSMIC RAYS. P. Morrison, E. P. Ney, J. A. Simpson, T. Gold, and G. Cocconi—Malcolm P. Savedoff, ed. Astrophysical Journal Supplement Series. Reprinted from Supplement No. 44, Volume IV, Pages 369-422, June 1960. Chicago, University of Chicago Press.

Four papers are included which were presented at the Symposium on Astronomical Aspects of Cosmic Rays held during the 102nd meeting of the American Astronomical Society in Rochester, New York. Separate abstracts have been prepared for all papers. (D.L.C.)

11892 COSMIC RAYS AS RECEIVED AT THE EARTH. E. P. Ney (Univ. of Minnesota, Minneapolis). Astrophys. J., Suppl. Ser., 4: (No. 44) 371-7(June 1960).

The present state of knowledge concerning cosmic radiation is discussed. The known cosmic-ray abundances are summarized and compared with the universal abundances of Suess and Urey. The rigidity and arrival direction aspects of cosmic radiation are treated. Both low- and high-energy rays are considered. Some intensity vs. energy data observed for cosmic protons and α particles are presented. (D.L.C.)

11893 VARIATIONS OF SOLAR ORIGIN IN THE PRIMARY COSMIC RADIATION. J. A. Simpson (Univ. of Chicago, Ill.). Astrophys. J., Suppl. Ser., 4: (No. 44) 378-405(June 1960).

The evidence for acceleration of particles in the solar system and galaxy is reviewed in the light of recent experimental studies of high-energy solar-flare particles. Also reviewed are experiments and observations of changes in intensity, composition, and spectrum of the galactic cosmic radiation at low energies which provide the evidence for electromagnetic fields in interplanetary space of solar origin. (auth)

11894 ENERGETIC PARTICLE FLUXES IN THE SOLAR SYSTEM AND NEAR THE EARTH. T. Gold (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., Suppl. Ser., 4: (No. 44) 406-16(June 1960).

The effects of the sun on cosmic radiation as received by the earth and solar generation of cosmic radiation are discussed. There are two ways such solar particles can reach the earth: motion in spiral orbits along the magnetic lines of force (fast mode of propagation) and convection of magnetic fields by motion of gas masses (slow mode). The probable sequence of events in the Feb. 23, 1956 flare is outlined, and the observed increase in high-frequency radio-wave attenuation during this flare is reported. The ionospheric event and magnetic storm of Mar. 25, 1958 are interpreted in terms of the magnetic region changing its shape to include the earth and thus providing a slow mode of propagation for the energetic particles. The case of lower particle energies and the Van Allen belt is considered, and motions in the "magnetosphere" of the earth are treated in detail. The effects of the diurnal thermal convection pattern in the atmosphere on the flux density with height are studied. (D.L.C.)

11895 THE ORIGIN OF THE COSMIC RADIATION. Giuseppe Cocconi (Cornell Univ., Ithaca, N. Y.). Astrophys. J., Suppl. Ser., 4: (No. 44) 417-22(June 1960).

Cosmic rays are created in turbulent plasmas present in practically all astronomical objects. Their diffusion in space is governed by their transport mean-free path, which increases as the cosmic-ray energy increases. On the earth the small energy cosmic rays (10^9 to 10^{12} ev) are mostly contributed by stars present in the region of the spiral arm where the earth is located. The moderate energy ones (10^{12} to 10^{16} ev) come mostly from novae and supernovae near the center of the galaxy via diffusion in the galactic halo. The most energetic rays (>10^{16} ev) arrive instead from other galaxies and from the intergalactic spaces. The data on the mass spectrum, the energy spectrum, and the angular distribution of the cosmic rays arriving on the earth are consistent with this picture. (auth)

11896 ASYMMETRY IN THE RECOVERY FROM A VERY DEEP FORBUSH-TYPE DECREASE IN COSMIC-RAY INTENSITY. D. C. Rose and S. M. Lapointe (National Research Council, Ottawa). Can. J. Phys., 39: 239-51 (Feb. 1961). (NRC-6133)

The intensity–time curves for cosmic rays recorded at some 30 stations distributed all over the world are examined for structure in the recovery period from the third in

a series of three closely spaced Forbush type decreases which occurred in the middle of July 1959. It is shown that the structure of intensity peaks is regular and that these occur at each station at the same effective local time. It is found that this is consistent with the hypothesis that recovery from a very deep Forbush type decrease is first apparent in directions making 15 and 165° with the sun–earth line, respectively. The analyses suggest further that during recovery from this deep Forbush decrease, temporary openings appeared in the intensity depressing mechanism which allowed intensity increases in limited directions. (auth)

11897 COSMIC-RAY PRODUCED MANGANESE-53 IN IRON METEORITES. J. P. Shedlovsky (Gulf Research & Development Co., Pittsburgh). Geochim. et Cosmochim. Acta, 21: 156-8(1960). (In English)

The radioactivity of manganese in three iron meteorites was measured. The activities found were ascribed to cosmogenic Mn^{53}. The meteorite samples were dissolved in aqua regia and a small portion of the solution set aside for chemical analysis. After the analysis, the manganese was counted as MnO_2 with a low-level β flow counter. The samples were also counted for γ activity to eliminate any effect of Mn^{54} contamination. Results showed considerably more Mn^{53} activity than predicted by Sheline. This indicated that the low-energy secondary nucleon flux in meteorites is much larger than was previously assumed. (M.C.G.)

11898 THE SUDDEN, BRIEF INCREASE OF COSMIC RADIATION ON MAY 4, 1960, DURING THE RECORDING OF THE NUCLEON COMPONENT ON THE JUNGFRAU PEAK. H. Debrunner, F. G. Houtermans, and W. Londt (Physikalisches Institut der Universität, Bern, Switzerland). Helv. Phys. Acta, 33: 706-8(1960). (In German)

On May 4, 1960, a sudden brief increase of the intensity of the nucleon component was recorded on the Jungfrau peak at a height of 3550 m. The deviations from the mean value of $I_0 = 3 \times 10^6$ cph are tabulated and shown graphically. It is seen that between 10:30 and 11:00 GMT there was an increase of $9.3 \pm 0.6\%$. The maximum deviation was recorded at 10:50 ± 2 min. After 11:00 the intensity decreased and after 12:30 the intensity level dropped back to the values recorded before the increase. The explosive increase was very brief in comparison with other earlier events. At the onset of the increase, the recording site was just outside of the "impact" zone of the solar flare of the same day. (J.S.R.)

11899 DAY TO DAY CHANGES IN THE DAILY MEAN INTENSITY OF COSMIC RAYS. R. P. Kane, S. R. Kane, and B. A. Holla (Physical Research Lab., Ahmedabad, India). Indian J. Phys., 34: 493-505(Nov. 1960).

Data obtained at Kodaikanal (geomag. lat. 1°N, altitude 2300 meters) for cosmic-ray mesons and the nucleonic component are analyzed for the first 12 months of the IGY (July 1957 to June 1958). Day-to-day changes of the mean intensity and their relationship with geomagnetic phenomena are studied. Comparison is made with neutron monitor data at Huancayo, Ottawa, and Resolute. A variation spectrum of the type $\delta D(E)/D(E) \propto E^{-1}$ is obtained. (auth)

11900 IONIZATION OF E-LAYER BY X-RAYS. S. N. Ghosh and Sharda Nand (Univ. of Allahabad, India). Indian J. Phys., 34: 516-26(Nov. 1960).

The transmission curves for solar radiations in the x-ray and ultraviolet regions through the earth's atmosphere, obtained from rocket data and absorption coefficients, were utilized for determining the radiation responsible for E-layer ionization. It is found that only x rays in the wavelength region 5 to 100 A are absorbed in the region of the atmosphere occupied by E-layer. The amount of energy absorbed is 0.19 erg cm^{-2} sec^{-1}. The number of ions produced by (1) absorbed x rays, (2) ejected photoelectrons produced by x rays, and (3) Auger effect induced by x rays was calculated and found to be 4×10^8, 5.6×10^9, and 2.5×10^8 cm^{-2} sec^{-1} $column^{-1}$, respectively, and the total rate of production of ions in the E-layer is 6.2×10^9 cm^{-2} sec^{-1} $column^{-1}$. This value agrees with that obtained from substituting the value of effective recombination coefficient and electron density for E-layer in the expression $q = \alpha N_e^2$. The temperature of the sun corresponding to different wavelength regions is calculated from data obtained from rocket-borne experiments. The calculated values agree with those given by Nicolet. (auth)

11901 LATITUDE DEPENDENCE OF NUCLEONIC INTENSITY DURING AUGUST 24–SEPTEMBER 20, 1957. Lekh Vir and P. S. Gill (Gulmarg Research Observatory, India). Indian J. Phys., 34: 531-2(Nov. 1960).

For the period Aug. 24 to Sept. 20, 1957, in which a large Forbush type decrease occurred, the relative amplitude of the decrease in the cosmic nucleonic component intensity was computed for ten sea level stations. The results, plotted on an amplitude vs. latitude graph, show a minimum nonsymmetrical about the geomagnetic equator and no evidence of curve flattening at 82.9°N. (D.L.C.)

11902 CHARGED PARTICLES IN THE INNER VAN ALLEN RADIATION BELT. A. H. Armstrong, F. B. Harrison, H. H. Heckman, and L. Rosen (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Research, 66: 351-7(Feb. 1961).

A nuclear emulsion stack was flown through the lower part of the inner Van Allen radiation belt a few days after the intense solar flares of July 10 to 16, 1959. The stack 'looked out' through a thin window on the mounting plate at the rear of the nose cone. Protons with incident energies down to 42 Mev were recorded. The total proton flux is about one-third that reported by Freden and White; the difference may be due to the lower peak altitude of the flight reported here. Above 100 Mev the proton spectrum is consistent with the neutron albedo hypothesis. Below 100 Mev, however, there is evidence of structure with a peak or plateau in the region of 80 Mev. This structure may be due to solar protons. (auth)

11903 THEORY OF X-RAY EMISSION OF THE SUN. G. Elwert (Univ. of Tübingen, Ger.). J. Geophys. Research, 66: 391-401(Feb. 1961).

The temperature T of the corona is discussed first since the spectral distribution of the x radiation depends on the value of T. The cross sections for electronic collisions computed by Schwartz and Zirin for S waves yield an upper limit of T which is 1.3 to 1.4×10^6°K. In pursuance of earlier calculations, the x-ray emission of the corona by free-free and free-bound as well as by line emission is discussed. The theoretical results are compared with the observations. The effect of the radiation in the atmosphere of the earth and the intensity distribution across the solar disk is summed up. The emission of the transient region to the chromosphere and of hot spots is considered. Finally the x radiation during a flare is investigated; some conclusions are drawn from the observations on the physical state of the emitting gas. (auth)

11904 THE COSMIC RAY FLARE ON NOVEMBER 12, 1960, AND SOLAR ACTIVITY DURING THE PERIOD NOVEMBER 10–15, 1960. Nature, 189: 438-40(Feb. 11, 1961).

A short account is given of the optical, radioastronomical, cosmic-ray, and earth-current observations at Nera Ob-

servatory at Paramaribo (Surinam) and Hollandia (New Guinea) of the solar activity of November 12, 1960, passing the central meridian at heliographic latitude 27°N. Flare events from November 10 to 15 are summarized, and H_α radiation photographs of the November 12 flare are discussed. The intensity of an unusually strong outburst at 2980 Mc/sec on November 12 is shown and discussed. A diagram is included showing the flare effect with a standard duplex neutron monitor. A parallelism in two flare-geomagnetic connection events is noted. (T.R.H.)

11905 NOTE ON ENDING PARTICLES IN NUCLEAR EMULSIONS EXPOSED TO THE PRIMARY COSMIC RADIATION. C. J. Waddington (Univ. of Bristol, Eng.). Nuovo cimento (10), 18: 820-2(Nov. 16, 1960). (In English)

It was previously shown that cosmic-ray intensity variations may be studied by examining the rate of production of ending particles, ρ, in nuclear emulsions exposed to primary cosmic radiation. Some further measurements of ρ are reported, and precautions for best results from use of the technique are pointed out. (T.R.H)

11906 THE FLUX OF PRIMARY COSMIC RAY α-PARTICLES OVER SOUTHERN ENGLAND. A. Mason (Coll. of Technology, Portsmouth, [Eng.]). Nuovo cimento (10), 18: 1037-8(Dec. 1, 1960). (In English)

The flux of α particles in primary cosmic radiation was measured in a stack of nuclear emulsions exposed on November 20, 1958, over southern England. The 434 tracks produced by α particles entering the stack were detected by scanning the emulsions along a line 1 cm below the top edge. The flux of α particles at the scan line was 77 ± 8 α particles/$m^2 \cdot Sr \cdot S$. Extrapolating this value to the top of the atmosphere, a value of 121 ± 15 α particles/$m^2 \cdot Sr \cdot S$ was obtained. (M.C.G.)

11907 STUDIES ON EXTENSIVE AIR SHOWERS. PART I. SEA LEVEL OBSERVATIONS ON THE VARIATION WITH SHOWER SIZE OF THE TOTAL NUMBER OF NUCLEAR-INTERACTING PARTICLES IN SHOWERS OF $(10^4 + 2.5 \cdot 10^6)$ PARTICLES. B. K. Chatterjee, G. T. Murthy, S. Naranan, B. V. Sreekantan, and M. V. Srinivasa Rao (Tata Inst. of Fundamental Research, Bombay). Nuovo cimento (10), 18: 1148-56(Dec. 16, 1960). (In English)

An experiment carried out at sea level on the lateral distribution of nuclear-interacting particles in air showers and the variation of their number with the size of the showers is described. The showers recorded ranged in size from 10^4 to $2.5 \cdot 10^6$ particles. The results indicate that the number of nuclear-interacting particles is proportional to $N_e^{0.45 \pm 0.05}$ for showers of size N_e less than about $6 \cdot 10^5$ particles and the number is proportional to $\sim N_e^{1.2}$ for larger sizes. What has been obtained in this experiment and in similar experiments conducted by other groups is the average number of nuclear-interacting particles in a large number of showers of a given size. The possibility that such an average may not be meaningful if large intrinsic fluctuations (other than normal statistical variations) exist is pointed out. (auth)

11908 HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION AT PRINCE ALBERT, CANADA. [PART] II. H. Aizu (Univ. of Tokyo), Y. Fujimoto, S. Hasegawa, M. Koshiba, I. Mito, J. Nishimura, K. Yokoi, and Marcel Schein. Phys. Rev., 121: 1206-18(Feb. 15, 1961).

The investigation of the low-energy primary cosmic radiation was extended to include the heavier elements of $Z \geq 9$; the light elements of lithium, beryllium, and boron; and α particles. The energy spectra of all components show a general similarity in shape. A possible deviation of the light-element spectrum from this similarity is discussed. The abundances of various elements in the low-energy region of 200 to 700 Mev per nucleon are essentially the same as observed in the higher energy region. (auth)

11909 SOLAR-PRODUCED COSMIC RAYS NEAR THE NORTH AND SOUTH POLES. M. A. Pomerantz, S. P. Duggal, and K. Nagashima (Franklin Inst., Swarthmore, Penna.). Phys. Rev. Letters, 6: 123-5(Feb. 1, 1961).

Neutron monitor data are presented which were collected at Thule near North Pole and McMurdo near South Pole on Nov. 12 and 15, 1960, and which appear to be associated with a 3+ solar flare. The data, plotted as % deviation from preflare level and as $\Delta I(\text{McMurdo})/\Delta I(\text{Thule})$, show a two-humped increase and relative increase at McMurdo on Nov. 12 but only a one-humped increase and no relative increase at McMurdo on Nov. 15. The onset times are approximately the same at both stations for both events. The implications of the data regarding anisotropy of cosmic radiation are discussed. (D.L.C.)

11910 CLOUD-CHAMBER OBSERVATIONS OF PRIMARY COSMIC-RAY ELECTRONS. James A. Earl (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 6: 125-8(Feb. 1, 1961).

Data are reported for the flux of high-energy (0.3 to 3.0 Bev) electrons and gamma rays observed in a balloon at the top of the atmosphere. Electrons and gamma rays were identified by the electron-photon cascade showers produced in the lead plates of the cloud chamber. Eleven electrons were observed, mostly in the 0.5- to 2.0-Bev range, which gives an electron flux I_e with more than 0.5-Bev energy of 32 ± 10 particles/m^2/sec/sr, of which no more than $13 \pm 10\%$ is due to secondaries. The proton flux I_p was calculated to be 1100 ± 100 particles/m^2/sec/sr, and the possible reasons for the discrepancy of the I_e/I_p ratio ($3 \pm 1\%$) with the 1949 value ($\leq 0.6\%$) are discussed. The electron density computed from I_e is 1.3×10^{-12} cm^{-3} and appears to explain galactic radio noise observations. The portion of I_e arising from interactions in interstellar space is estimated to be the same as that arising from interactions in the atmosphere ($13 \pm 10\%$). (D.L.C.)

11911 ELECTRONS IN THE PRIMARY COSMIC RADIATION. Peter Meyer and Rochus Vogt (Univ. of Chicago). Phys. Rev. Letters, 6: 193-6(Feb. 15, 1961).

Balloon flight data are reported which indicate a primary electron flux entering the top of the atmosphere. In three balloon flights, data were collected during the ascent and for ~10 hr under 3 to 5 g/cm^2 residual atmosphere, using a detector system surrounded by plastic scintillation counters in anticoincidence and containing a lead stack. Primary electrons above the calculated geomagnetic cutoff of 100 Mev were found, and the primary electron flux is calculated to have the following upper and lower limits for the energy ranges: 28 to 31×10^{-3}/cm^2sec sr for 25 to 100 Mev, 3.5 to 11×10^{-3}/cm^2sec sr for 100 to 1300 Mev, and 0 to 8×10^{-3}/cm^2sec sr for >1300 Mev. (D.L.C.)

Criticality Studies

11912 (ANL-6212) SOME PHYSICS CALCULATIONS ON THE PERFORMANCE OF LARGE FAST BREEDER POWER REACTORS. S. Yiftah and D. Okrent (Argonne National Lab., Ill.). Dec. 1960. Contract W-31-109-eng-38. 32p.

Critical mass, spectrum, breeding ratio, and coolant removal coefficients were calculated for a series of large Pu–U^{238}-fueled sodium-cooled fast-breeder power reactors, using a new 16-group cross-section set based in part

on recent microscopic cross-section measurements. The parameters studied include reactor size, plutonium isotopic content, and type of structural material. Reactors cooled with Pb–Bi eutectic and those containing U^{233}–Th fuel were examined. (auth)

11913 (NP-9688) EXACT SOLUTION OF A CRITICAL PROBLEM FOR A SLAB. Report No. 160/IX. R. Zelazny (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). June 1960. 14p.

Using the Case method of expansion of the angular neutron distribution into series with respect to eigenfunctions of the plane Boltzmann equation, the critical problem of a slab was formulated. By means of symmetry considerations the problem of boundary condition was reduced to one singular integral equation, which was treated by classical methods. This treatment gave an integral equation for expansion coefficients which, by means of a simple transformation, can be reduced to a Fredholm type with a regular kernel, and an additional equation which plays the role of an exact critical condition. (auth)

Elementary Particles and Radiations

11914 (GA-1687) INELASTIC SCATTERING OF THERMAL NEUTRONS PRODUCED BY AN ELECTRON ACCELERATOR. W. L. Whittemore and A. W. McReynolds (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 16, 1960. 32p.

Results are reported for measurements made on total neutron scattering cross sections and on neutrons scattered inelastically. Cross-section measurements were made for H_2O at 3, –5, and –196°C. For energies near 0.1 ev, the various curves tended to merge although the cross section of –196°C ice was greater than that for ice at –5°C or for water. Similar measurements were made for D_2O at 9, –1, and –196°C. The three curves merged in the energy region above about 0.02 ev. An increase in cross section such as that determined for H_2O was not observed. Measurements for the energy dependence of the total scattering cross section were made for water and polyethylene. It was found that water is a better moderator in the energy region from 0.05 to 0.2 ev than polyethylene. Neutron reactions were used to study the first excited energy levels in hydrides of U, Li, Ti, Zr, and Y. These studies gave direct information on hydrogen binding. The temperature dependence of the scattering cross section of BeO was studied for neutrons with energy below the Bragg cutoff. (M.C.G.)

11915 (JINR-D-522) INTERFERENCE OF THE COULOMB AND NUCLEAR SCATTERING AT HIGH ENERGIES. B. P. Bannik, V. G. Grishin, and R. N. Fedorova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 24815.

11916 (JINR-P-249) ANALIZ ROZHDENIYA CHASTITS NA NUKLONAKH PO PARTSIAL'NYM VOLNAM. (Analysis of Particle Production by Nucleons on Fractional Waves). Ya. Fisher and S. Chulli (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1958. 10p.

A method is given for calculating the S-matrix angular dependence for $b + N \rightarrow N' + \sum_{i=1}^{n} b_i^1$ processes, where N and N′ are nucleons and $\underline{b}$ and $\underline{b}_i^1$ are either π mesons or photons. (tr-auth)

11917 (JINR-P-311) METOD VYCHISLENNYA FAZOVYKH OB'EMOV. (Calculation Method for Phase Volumes). L. G. Zastavenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1959. 22p.

A method was developed for calculating phase volumes for two, three, four, and five particles. The order of accuracy of the method diminishes with increased particle number $\underline{n}$, and at $n = 5$ the error does not exceed 5%. (tr-auth)

11918 (JINR-P-477) TENZOR KORRELYATSII POLYARIZATSII NA POLYARIZOVANNOM PUCHKE PROTONOV. (Correlation Tensor of Polarizations on a Polarized Proton Beam). A. F. Pisarev and Kh. R. Poze (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 14p.

Expressions are developed for polarization tensors in polarized proton elastic scattering on hydrogen as functions of scattering matrix elements. The formulas consider the relativistic corrections demanded by reaction kinematics and the rotation of relativistic particle spins. The derived equations are used in an analysis of special cases of spin correlation. (tr-auth)

11919 (NP-9647) NOMOGRAMS FOR LORENTZ TRANSFORMATIONS. Report No. 166/VI. Z. Koba and P. Zieliński (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Sept. 1960. 18p.

Nomograms and procedures for using them are given for Lorentz transformations in high-energy interactions, particularly the transformation of energy and angle between the laboratory and the center-of-mass systems and the determination of angle-energy relation of elastic scattering of equal-mass particles. Examples of the application of these nomograms in nucleon-nucleon interactions are given. (D.L.C.)

11920 (NP-9797) THE BREMSSTRAHLUNG MONOCHROMATOR. Technical Report No. 21. J. S. O'Connell, P. Tipler, and Peter Axel (Illinois. Univ., Urbana. Physics Research Lab.). Jan. 1961. 145p. Contract Nonr 1834 (05).

Design, construction, and preliminary use of a variable-energy photon monochromator are reviewed. The device uses bremsstrahlung photons from the external electron beam of a 25-Mev betatron. The photon-energy identification is accomplished by measuring the electron energy before and after the bremsstrahlung process. Elastic scattering cross sections were determined for gold at gamma energies between 11.4 and 17.8 Mev. Elastic scattering measurements were made for the 15.1-Mev level of C^{12}. Some applications of the bremsstrahlung monochromator to other photonuclear reactions and the theory of focusing in the inclined plane magnetic spectrometer are discussed. (B.O.G.)

11921 (NP-9837) GAMMA RAY SCATTERING. Eighth Quarterly Technical Progress Report for September 18, 1960, through December 18, 1960. John A. Wethington, Jr. and R. A. Karam (Florida. Univ., Gainesville). Dec. 18, 1960. 14p. Contract NOas 59-6013-c.

The experimental results discussed previously for the pulse-height spectra were converted to photon spectra for lead shields and polyethylene-lead shields in the combination and laminated forms. The results are tabulated and graphed for gamma energies of 0.328 to 1.33 Mev. The dose rate ratios for the various shields were computed from the photon spectra. The laminated polyethylene-lead shield was concluded to be the most efficient shield for removing primary photons from the beam. (B.O.G.)

11922 (TID-11697) PROGRESS REPORT [ON USE OF BUBBLE CHAMBER] FOR APRIL 1, 1960 TO MARCH 31, 1961. (Wisconsin. Univ., Madison). 10p. Contract AT (11-1)-881.

A study was made of a separated meson K^+ beam using a 30-in. propane bubble chamber. The ~230,000 pictures taken during the run were scanned, and preliminary results of analyses are given for: $\Theta_1-\Theta_2$ mass difference; leptonic decays of K^θ mesons; meson (π) production by K^+ mesons in propane; polarization of protons from K-p scattering; scattering of Λ hyperons on hydrogen; and hyperfragment lifetimes. An analysis of a 15-in. liquid hydrogen bubble chamber in a 1.15-Bev/c K^- meson beam resulted in the discovery of resonances in (1) the $\pi-\Lambda$ system, as shown by the energy distribution of the final reaction products, $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$, and (2) the $K-\pi$ system, by studying the energy distribution of the final products in, $K^- + p \rightarrow \overline{K}^\theta + p + \pi^-$. Film studies of a $\pi^\pm$ meson beam in a 72-in. liquid hydrogen bubble chamber were scanned, and the results assessed to determine: (1) the relative sign of the decay asymmetry parameters of the Λ hyperon as compared to the Σ hyperon; (2) the $\Sigma^0-\Lambda$ relative parity; and (3) the $\Sigma^- \rightarrow n + \pi^-$ state. A study of 2-Bev/c π^- mesons in a 14-in. hydrogen chamber resulted in 45,000 useful pictures, which are being scanned and analyzed for high-energy $\pi-\pi$ interactions. Analyses were made for 100 interactions of the types $\pi^- + P \rightarrow \pi^+ + \pi^- + n$ and $\pi^- + P \rightarrow \pi^- + \pi^0 + p$, and 70 interactions of $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p$. (B.O.G.)

11923 (TID-11714) HIGH FREQUENCY LIMIT OF THE BREMSSTRAHLUNG SPECTRUM. R. T. Deck and C. J. Mullin (University of Notre Dame, Notre Dame, Ind.), and C. L. Hammer (Iowa State Univ. of Science and Technology, Ames). [1960?]. 30p.

The Bremsstrahlung cross section at the high frequency limit of the spectrum was evaluated to the first three nonvanishing orders in αZ for high-energy incident electrons. The power series in αZ, which occurs in the cross section, apparently converges rapidly enough to yield accurate results over a wide range of values of Z. The values obtained for the cross section are somewhat smaller than those predicted by the lowest-order (Fano) theory. (auth)

11924 (TID-11743) RESEARCH AND INVESTIGATION LEADING TO METHODS OF GENERATING AND DETECTING RADIATION IN THE 100 TO 1000 MICRON WAVELENGTH RANGE OF THE SPECTRUM. Quarterly Progress Report No. 19 [for] September 1, 1960 to December 1, 1960. P. D. Coleman, Jack R. Baird, Basil Hakki, and Joe Stafford (Illinois. Univ., Urbana. Electrical Engineering Research Lab.). Jan. 1, 1961. Contract AT(11-1)-392. 23p.

Activities are reported in a program to uncover ways in which a CW source of electromagnetic radiation can be developed for low millimeter and submillimeter wavelengths, and to develop ways of using radiation as a diagnostic tool for plasma physics. The approach to the generation problem presently being followed is discussed. Results of frequency conversion in plasmas include mixing a 0.1-watt 11-kmc signal with a 10-watt 9-kmc signal (used simultaneously to produce and maintain the discharge) to obtain a 20-kmc sum frequency with a conversion ratio of approximately 29 db. Verification of the computed electromagnetic modes in a gyromagnetic plasma was obtained, and data are being obtained on the behavior mode as a function of system parameters. In research on generation of millimeter and submillimeter coherent electromagnetic radiation, it was experimentally established that second coherence of a beam in a dielectric tube waveguide cannot take place if the length of the guide is less than the spacing of the bunches. A Doppler frequence shift scheme was analyzed which was designed to change the input 3-kmc power to 82.7 kmc. (For preceding period see TID-6997.) (J.R.D.)

11925 (UCRL-9450) CHARGED Σ-HYPERON PRODUCTION AND DECAY: ENERGETICS, LIFETIMES, AND BRANCHING RATIOS (thesis). John N. Dyer (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1, 1960. Contract W-7405-eng-48. 90p.

Charged Σ hyperons produced by negative K-meson interactions at rest with emulsion nuclei were studied. Estimates of the masses and lifetimes are presented, based upon range measurements of the pions involved in Σ production and decay. Statistical improvements were obtained in the Σ^+ mass and lifetime determined by the proton decay mode and the $\Sigma^- - \Sigma^+$ mass difference determined by K^- absorptions on free protons. The mass of the Σ^+ hyperon, determined by its decay at rest, is $M_{\Sigma^+} = 1189.33 \pm 0.22$ Mev (using 80 protons from $\Sigma^+ \rightarrow p + \pi^0$), and $M_{\Sigma^+} = 1188.75 \pm 0.54$ Mev (using 26 pions from $\Sigma^+ \rightarrow n + \pi^+$). These data were combined to yield $M_{\pi^0} = 134.0 \pm 1.0$ Mev, the first direct estimate of the mass of the neutral particle involved in the proton decay mode. From 56 $K^- + p \rightarrow \Sigma^\pm + \pi^\pm$ interactions with free protons, the following data were obtained from the hyperon ranges: $\Sigma^- - \Sigma^+$ range difference = 106.9 ± 4.3 $\mu(32\Sigma^-, 16\Sigma^+)$, $\Sigma^- - \Sigma^+$ mass difference = 6.32 ± 0.25 Mev, $M_{\Sigma^-} = (M_{\Sigma^+} + \Delta M) = 1195.65 \pm 0.33$ Mev, $M_{K^-} = 493.61 \pm 0.33$ Mev. In addition, 3 π^- mesons and 13 π^+ mesons were followed to rest in emulsion. The average momentum of the π^+ is found to be 2.76 ± 0.64 Mev/c less than that of the Σ^-; the anomaly has not been explained. The average momentum of the π^- is compatible with that of the Σ^+. The mass of the Σ^- hyperon has been measured by using 11 decays in flight, and is 1196.0 ± 1.1 Mev. This is compatible with the value obtained from the mass-difference method. Energy spectra of the Σ^+ and Σ^- hyperons emitted from complex nuclei indicate that ~18% of the Σ^- and ~9% of the Σ^+ are produced by multinucleon K^--capture processes. The lifetime of the Σ^+ hyperon, as determined from its proton decay mode, is $\tau^+ = 0.85^{+0.15}_{-0.11} \times 10^{-10}$ sec using 107 decays at rest and in flight, and $\tau^+ = 0.86^{+0.15}_{-0.17} \times 10^{-10}$ sec using 43 decays in flight only. Lifetimes determined from the pion decay modes, using events at rest and in flight, are $\tau^+ = 0.80^{+0.14}_{-0.11} \times 10^{-10}$ sec, and $\tau^- = 1.75^{+0.33}_{-0.30} \times 10^{-10}$ sec. The best value for the Σ^+ lifetime calculated from both decay modes is $\tau^+ = 0.82^{+0.10}_{-0.08} \times 10^{-10}$ sec. When only decays in flight via the pion modes are considered, the lifetimes are depressed, but experimental biases are detected and discussed. The following branching ratios have been found: $(\Sigma^+ \rightarrow p + \pi^0)/(\text{all } \Sigma^+) = 0.50 \pm 0.03$; $(\Sigma^+ \rightarrow p + \gamma)/(\Sigma^+ \rightarrow p + \pi^0) = (0/95)$; $(\Sigma^\pm \rightarrow \text{leptons})/(\Sigma^\pm \rightarrow \pi^\pm) = (0/129)$; and $(\Sigma^- \rightarrow \text{leptons})/(\Sigma^- \rightarrow \pi^-) = (0/67)$. (auth)

11926 SMALL-ANGLE COHERENT SCATTERING OF 500 KEV ELECTRONS. I. Berkes and I. Demeter (Central Research Inst., for Physics, Budapest, Hungary). Acta Phys. Acad. Sci. Hung., 12: 99-101(1960). (In English)

Small-angle coherent scattering of 502-kev electrons on thin aluminum and silver foils was investigated. The electron energy was determined by measuring the accelerating voltage with a rotating field meter. The values of wavelengths calculated from the accelerating voltage and measured from the diameter of diffraction rings agree within the error of measurement of ±1.5%. (auth)

11927 THE MOTT POLARIZATION EFFECT IN THE SCATTERING OF ELECTRONS ON THOMAS-FERMI AND HARTREE ATOMS. T. Tietz (Univ., Lodz, Poland). Acta. Phys. Acad. Sci. Hung., 12: 151-62(1960). (In German)

The effect of the electron shell of the scattering atom on the asymmetry effect was investigated. Since experimental investigations exist on scattering under 90°, this case was also treated. The potential path in the atom interior was handled by the Hartree or Thomas-Fermi model. The calculation for this potential path causes no important difficulties. The application of suitable approximations for the potential path considered in the atom interior possesses the advantage that all integrals occurring can be carried out in the closed form and that the limiting case of the pure coulomb field can be obtained by the corresponding boundary passage in the results. The Born-Dirac collision method in the Sauter representation is especially suitable for the treatment of the asymmetry effect. Its advantage with respect to the Dalitz treatment of the Born-Dirac collision method is its simplicity and its complete sufficiency for the correct treatment of the asymmetry effect. (tr-auth)

11928 BREMSSTRAHLUNG SPECTRUM IN SCATTERING OF NON-RELATIVISTIC ELECTRONS ON A SHIELDED COULOMB FIELD. T. Tietz (Univ., Lodz, Poland). Acta. Phys. Acad. Sci. Hung., 12: 189-92(1960). (In German)

A study was made to determine the effect that the screening of the nuclear field by the electron shell of the braking atom has on the bremsstrahlung. (J.S.R.)

11929 ON A POSSIBLE ISOTOPIC STRUCTURE OF THE D-PARTICLE. Bronisław Kuchowicz (Inst. for Nuclear Research, Warsaw). Acta Phys. Polon., 19: 559-64(1960). (In English)

A charge singlet for the recently discovered D-particle is proposed. This particle is included in the scheme of Rayski after a slight modification. Other possibilities in the framework of this scheme are also discussed. (auth)

11930 ON THE STATE OF A FERMI-SYSTEM WITH CORRELATION OF PAIRS OF PARTICLES WITH PARALLEL SPINS. II. THERMODYNAMICS. Zygmunt Galasiewicz (Joint Inst. for Nuclear Studies, Dubna, USSR). Acta Phys. Polon., 19: 683-90(1960). (In English)

The thermodynamics of the "anomalous" state of a Fermi-system (in which the correlation of pairs of particles with parallel spins is taken into account) were investigated. The transition temperature T_c to the "anomalous" state was found, as well as the temperature dependence of the specific heat for $T \approx 0$ and $T \approx T_c$. For $T = T_c$ the specific heat has a jump. In addition, formulas for the paramagnetic susceptibilities for $T \approx 0$ and $T \approx T_c$ were obtained. (auth)

11931 SPINOR FIELDS IN SPACES WITH TORSION. Robert Finkelstein (Univ. of California, Los Angeles). Ann. Phys. (N.Y.), 12: 200-21(Feb. 1961).

It is suggested that the short-range interactions lead to a torsion of physical space, as gravitational interactions lead to its curvature. The existence of torsion implies two kinds of parallelism, (+) and (–), which in turn imply two types of spinor field, $\psi(+)$ and $\psi(-)$. If the geometry is symmetric with respect to (+) and (–) parallelisms, then $\psi(+)$ and $\psi(-)$ have no vector or electromagnetic coupling, and the geometry may be called neutral. The simplest neutral geometry with variable torsion is derivable from a Lagrangian in which a pseudoscalar Yukawa field (the torsion potential) is coupled by pseudovector coupling to $\psi(+)$ and $\psi(-)$. If the geometry does not have neutral symmetry, then $\psi(+)$ and $\psi(-)$ behave like a charge doublet. The hypercharge and the parity of this charge doublet are determined by the weight of the spinor under general coordinate transformations. It follows from the model that leptonic ($m = 0$) particles are not coupled to the torsion. (auth)

11932 POSSIBLE RELATIONS AMONG THE MESON-BARYON COUPLING CONSTANTS. D. B. Lichtenberg (Michigan State Univ., East Lansing). Ann. Phys. (N.Y.), 12: 264-82(Feb. 1961).

It is assumed that the strong interactions of the mesons and baryons can be described in terms of a Lagrangian containing at most eight coupling constants. A simple assumption is then made that only one magnitude g is required to describe all the pion-baryon couplings and that one magnitude f is sufficient to describe the couplings of the baryons to K mesons. Within this restriction, there are $3^8 = 6561$ ways to write down the Lagrangian, since each of the eight coupling constants may be positive, negative, or absent. It is shown that many of these possibilities lead to equivalent descriptions of the strong interactions, and that still other possibilities lead to predictions in contradiction to experiment. However, several hundred nonequivalent Lagrangians satisfying the assumptions are not eliminated by the arguments. Examination of a number of the remaining possibilities in fourth-order perturbation theory indicates that some of them are more likely than others, but none can be ruled out by the arguments. (auth)

11933 INITIAL VALUE DATA FOR POISSON BRACKETS IN GENERAL RELATIVITY. John G. Fletcher (Palmer Physical Lab., Princeton, N. J.). Ann. Phys. (N.Y.), 12: 283-94(Feb. 1961).

As a preliminary step toward constructing the commutators of a quantized theory of general relativity, Poisson brackets for the classical theory are found on an initial space-like surface. These can then be extended over all space-time by solving the equations of motion. The theoretical structure used to find the brackets is an extension of the formalism of Schwinger. The brackets obtained are determined only up to a gage transformation. (auth)

11934 NUMERICAL INTEGRATION OF THE EQUATION OF THE MOVEMENT OF A PARTICLE IN AN ELECTROMAGNETIC FIELD. Renée Lapeyre. Compt. rend., 251: 2144-6(Nov. 14, 1960). (In French)

Some formulas are proposed which permit the numerical integration, by the Rung-Kutta method, of a system of second-order differential equations, corresponding to the movement of a particle in space. (tr-auth)

11935 A LEPTON MODEL. FIELDS OF THE ELECTRON-MUON AND THE NEUTRINO. Kuo-Hsien Tzou (Institut Henri Poincaré, Paris). Compt. rend., 251: 2659-61(Dec. 5, 1960). (In French)

A unified model is proposed for the electron and muon which are the two different states of a ψ field with respect to the symmetry M. The field ψ contains two states of different intrinsic mass. (tr-auth)

11936 A LEPTON MODEL. ELECTROMAGNETIC INTERACTION AND WEAK INTERACTION. Kuo-Hsien Tzou (Institut Henri-Poincaré, Paris). Compt. rend., 251: 2895-7(Dec. 19, 1960). (In French)

Electromagnetic and weak interactions are introduced into the lepton model proposed previously (Compt. rend. 251, 2659(1960)). The lepton current of the weak interaction is exactly like the electric current of the electron-muon. The four-component theory of the neutrino is necessary for M symmetry and the neutrinos associated with $\underline{e}$ and μ are two particles of opposed helicity. (tr-auth)

11937 THE REACTIVE FORCE PRODUCED BY CHERENKOV RADIATION IN A CRYSTAL. V. N. Kurdyumov (Lomonosov, Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 134, 563-6(1960). Sept. 21. (In Russian)

The Maxwellian distribution was used to obtain the scalar and vector potential expressions for charged particles mov-

ing in a crystal with velocity v. Expressions for the reactive force produced by Cherenkov radiation were obtained in rectilinear coordinates for both the ordinary and extraordinary wave radiations. The asymmetrical cone of radiation along the motion of the particles was calculated and a simplified relation for the retarding force was obtained. For conditions of small angles and ϵ_e greater than ϵ_0 stabilized particle motion is predicted. (TTT)

11938 RADIUM-MESOTHORIUM-BERYLLIUM NEUTRON SOURCE. M. A. Bak and N. S. Shimanskaya. Izmeritel'naya Tekh., No. 12, 42-5(Dec. 1960). (In Russian)

Mesothorium is an isotope of radium with a half-life of 6.7 years which decays to a series of short-lived isotopes, (Th X, Th A, Th B, Th C, Th C', and Th C''). Thus the neutron yield of a mixed radium-mesothorium-beryllium source is a function of time determined by the initial content of radium and thorium in the source, the half-lives of the decay products and the yields of the reaction $Be^9(\alpha,n)C^{12}$ for the separate isotopes. Measurements of the number of neutrons emitted per second by a source containing 198 mc of radium and 112 mg-equivalents of radium of mesothorium were followed for 10 years. It was found that the experimental values agreed well with the calculated values. On the basis of these results, a curve was constructed that gives the neutrons per second emitted by sources containing various ratios of radium to mesothorium at intervals of time from 0 to 30 years. Conversely, the ratio of radium to mesothorium in a source can be determined to an accuracy of 1% from changes in the neutrons per second emitted by the source over a period of time. (TTT)

11939 INDUCED BREMSSTRAHLUNG EMISSION AND ABSORPTION. G. S. Saakyan (Physics Inst., The Academy of Sciences., Armenian S.S.R.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 5, 99–104(1959). (In Russian)

The bremsstrahlung process in which an electron in a nuclear Coulomb field does not emit but absorbs quanta from the external field was analyzed. The probability of induced quantum absorption was calculated assuming the presence of an external electromagnetic field emission in addition to that in the space. At a temperature $T > \omega/a$ (ω is the quantum energy), the probability of induced processes exceeds the probability of ordinary bremsstrahlung; at $\omega \ll aT$ the probability of bremsstrahlung absorption and quantum emission is equal. At $\omega = 1$ Mev the corresponding temperature is 10^{10} degrees. Such a temperature exists in the internal regions of stars. At $T > \omega/a$ the probability of bremsstrahlung and particle acceleration is about equal. However, at lower temperatures the probability of bremsstrahlung is more probable than the acceleration and only a small percentage of particles is accelerated. (R.V.J.)

11940 INTENSITY OF X-RAY REFLECTION WAVES AS A FUNCTION OF THE REFLECTING CRYSTAL SHAPE. P. A. Berzirganyan and A. G. Akritov (Erivan State Univ., The Armenian Inst. of Agriculture). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk 13, No. 2, 115-22 (1960). (In Russian)

The dynamic theory of x-ray interference was analyzed for two cases of nonabsorbing crystals. In the first instance the infinite crystals are oriented in the x direction while in the second they are oriented in the y direction. (R.V.J.)

11941 EMISSION OF A CHARGE PASSING PARALLEL TO THE INTERFACE OF TWO MEDIA. G. M. Garib'yan and O. S. Mirgelyan (Inst. of Physics, the Academy of Sciences, Armenian S.S.R., and Inst. of Mathematics and Mechanics, the Academy of Sciences, Armenian S.S.R.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk 13, No. 2, 123-30(1960). (In Russian)

The radiation emission of charged particles in flight parallel to the interface of two media is analyzed, and new data are derived concerning the emission in the medium where the particle itself is in motion. (R.V.J.)

11942 TRANSITION EMISSION FORWARD. N. A. Korakhmzyan (Erivan State Univ.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk 13, No. 2, 139-45 (1960). (In Russian)

The previously derived expression for the transition forward emission of a charged particle in perpendicular incidence to the interface of two media showed that the emission is concentrated in small angles around the trajectory and has frequency exceeding the optical. The dependence of the complete transition emission forward on the charged particle angle of incidence to the plane interface of two media was analyzed. The angular and frequency distribution at inclined angle of incidence to the interface of two media with dielectric constant ϵ_2 and ϵ_1, was found (R.V.J.)

11943 ON APPROXIMATION SOLUTION OF EQUATIONS FOR RADIATION TRANSMISSION IN ATMOSPHERE. M. S. Malkevich (Inst. of Atmosphere Physics, Academy of Sciences, U.S.S.R.). Izvest, Akad. Nauk S.S.S.R., Ser. Geofiz. 1541–6(Oct. 1960). (In Russian)

Radiation behavior in plane-parallel, purely scattering atmosphere is determined by a system of equations for radiation transmission and boundary conditions. (R.V.J.)

11944 MASS SPECTRA OF BARYONS. Seitaro Nakamura and Ken Kawarabayashi (Tokyo Univ.). J. Phys. Soc. Japan, 16: 130(Jan. 1961). (In English)

Mass correction terms are derived for baryons (Ξ,N,Σ,Λ) on the basis of the following assumptions: (1) Baryons are different states of one particle; (2) a new quantum number κ charge is introduced; and (3) two orthogonal Euclidian spaces are used, one for the κ charge and the other for the electric charge. The mass splitting for baryons is predicted with $M_\Xi > M_\Sigma = M_\Lambda > M_N$. The mass splitting is of the right order of magnitude if $M_0 \sim 1000$ Mev, $g^2/4\pi \sim 1$, and a reasonable cutoff is assumed. (D.L.C.)

11945 COMPOUND PAIR STATES IN IMPERFECT FERMI GASES. H. Kümmel (Max-Planck-Institut für Chemie, Mainz). Nuclear Phys., 22: 177-83(Jan. 1961). (In English)

The Bethe-Goldstone equation is replaced by a rigorous nonlinear integro-differential equation determining the two-particle correlations and the interaction energy. This nonlinear equation is solved for vanishing total momentum and separable potential. The hole-hole and particle-hole interactions as well as the three- and four-particle clusters are neglected. There are no singularities in this more rigorous equation. For the values of the two-particle energy for which singularities occur, if the quadratic terms are neglected, the solutions are of "compound type," i.e., the localized part has a large (but finite) amplitude compared with the unperturbed plane wave. (auth)

11946 ON DERIVING EQUATIONS FROM THE MANDELSTAM REPRESENTATION. A. V. Efremov, V. A. Meshcheryakov, D. V. Shirkov, and H. Y. Tzu (Joint Inst. for Nuclear Research, Dubna, USSR). Nuclear Phys., 22: 202-6(Jan. 1961). (In English)

A new recipe is proposed for deriving the integral equations for partial-wave scattering amplitudes on the basis of the dispersion relations at a fixed angle and the unitarity condition. The method is illustrated by applying it in the

simplest case of $\pi\pi$-scattering. The results on the πN-scattering are summarized in brief. (auth)

11947 A NEW MAJORANA FIELD THEORY. H. Umezawa and A. Visconti (Faculté des Sciences, Marseille). Nuclear Phys., 22: 262-82(Jan. 1961). (In English)

The various isospin schemes for strong and weak interactions are reviewed, and it is shown that they can be reduced to a common scheme by writing down an invariant of a set of 2×2 matrices whose elements are linear combinations of the particle wave functions. Various properties and difficulties of these schemes are discussed. A scheme is proposed wherein each set of a particle and its antiparticle is described by a quaternion. Several interesting properties of this scheme are pointed out: the rule for constructing quaternions leads directly to charge conservation; the strangeness conservation for strong interactions and the rule $|\Delta S| = 1$ for the weak interactions are direct consequences of this theory; furthermore, all the unwanted electromagnetic interactions are naturally excluded. (auth)

11948 THE MOMENT OF INERTIA OF LARGE SUPERFLUID FERMION SYSTEMS. Richard E. Prange (Univ. of Copenhagen). Nuclear Phys., 22: 283-300(Jan. 1961). (In English)

The moment of inertia of a superfluid system is calculated according to the Bardeen-Cooper-Schrieffer-Bogoliubov model. To obtain sensible results, it is necessary to include not only the independent pair excitations but also the phonon excitations. A method of calculating the effects of these excitations is developed, which exhibits the fact that many of the excitations cannot be easily produced, since there is an "energy gap" against their formation. Other excitations are, however, easily produced. These excitations are characteristic of a macroscopic irrotational flow and may be described loosely as a center-of-mass motion of the "bound" pairs of the Bardeen-Cooper-Schrieffer-Bogoliubov theory. Thus the irrotational flow moment of inertia is predicted. This result does not apply to finite systems in which the shell spacing is significantly large. Corrections to the formula of Belyaev for finite nuclei are suggested. Finally, some remarks are made on the origin of the cranking model. (auth)

11949 THE POLARIZATION OF NEUTRONS FROM THE $Li^7(p,n)Be^7$ REACTION (I). S. E. Darden, T. R. Donoghue, and C. A. Kelsey (Univ. of Notre Dame, Ind.). Nuclear Phys., 22: 439-50(Feb. 1961). (In English)

Previous measurements on the polarization of neutrons from the $Li^7(p,n)Be^7$ reaction have been extended. Left-right asymmetries in the scattering of neutrons emitted from the reaction at a laboratory angle of 50° have been measured using scatterers of Li^6, Li^7, O, and Mg. Measurements were carried out for laboratory scattering angles near 90° and for neutron energies between 85 and 420 kev. Data obtained using the Li^7, O, and Mg scatterers were analyzed to give the polarization of the neutrons emitted from the reaction. The measured polarizations are of the order of 0.4 down to 250 kev neutron energy, below which they decrease abruptly. Relatively small asymmetries observed using Li^6 as a scatterer suggest that the antiparallel spin S-wave interaction may be the stronger for this nucleus. (auth)

11950 MATRIX ELEMENTS FOR THE ALPHA-PARTICLE. L. Cohen (Univ. of Southampton, Eng.). Nuclear Phys., 22: 492-7(Feb. 1961). (In English)

The classification of alpha-particle wave functions given in an earlier paper is reformulated in terms of products of vectors and products of tensors. It is shown how, after summing over spins and isobaric spins, the matrix elements may be expressed in terms of functions of interparticle distances only. (auth)

11951 NEUTRON POLARIZATION BY COULOMB SCATTERING. B. Margolis (Ohio State Univ., Columbus). Nuclear Phys., 22: 498-9(Feb. 1961). (In English)

The polarization of neutrons by Coulomb scattering is examined in the low-energy region ($kR \ll 1$) at energies corresponding to a Breit-Wigner s-wave resonance. It is found that there is virtually 100% polarization at small angles. (auth)

11952 CONNECTION OF SPINOR FIELDS. Hiroshi Nakamura (Tokyo Inst. of Tech.) and Toshiyuki Toyoda. Nuclear Phys., 22: 524-8(Feb. 1961). (In English)

It is proved that the field introduced by the connection of γ_l matrices can be eliminated by a suitable gage transformation, except in the case of the gravitational and electromagnetic fields. Discussions are given on related papers. (auth)

11953 ON THE $K_{\mu 3}$ and K_{e3} DECAY MODES. N. Brene, L. Egardt, and B. Qvist (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). Nuclear Phys., 22: 553-78(Feb. 1961). (In English)

On the basis of the usual local current-current coupling between the lepton fields and the boson fields, some general expressions were obtained for the muon (electron) and pion spectra and the muon polarization in an arbitrary direction taken as a function of the muon energy. The derivation of the muon spectrum and polarization involved a phase space integration over the pion momenta, on which, however, the two unknown form factors $f \pm (p_\mu p_K)$ describing the effect of strong interactions were dependent. By means of a covariant integration technique originally due to Berman, the phase space integral was recast into a sum of products of factors depending on the muon and kaon momenta alone and very simple integrals over the form factors. These integrals depend on the muon and kaon momenta only through their upper and lower limits. In the CMS of the decaying kaon, the factors depend solely on E_l, the muon, or electron energy. The general expressions were applied to two special examples, namely, constant form factors and form factors derived by MacDowell by means of a dispersion technique. The results for these cases are very much alike. (auth)

11954 APPROXIMATE EQUATIONS FOR PARTIAL π-K SCATTERING AMPLITUDES. P. S. Isaev and M. Sewerynski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). Nuclear Phys., 22: 663-76(Feb. 1961). (In English)

Approximate integral equations for partial $\pi-K$ scattering amplitudes were obtained with the help of the double Mandelstam representation in the low-energy range. (auth)

11955 ON THE LONGITUDINAL DEPOLARIZATION OF BEAMS OF SPIN ½ PARTICLES BY MULTIPLE COULOMB SCATTERING. G. Passatore (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo cimento (10), 18: 532-44(Nov. 1, 1960). (In English)

The average longitudinal depolarization of an electron beam by multiple Coulomb scattering was evaluated. The treatment is based on the iteration, extended to a whole succession of scatterings, of the matrix which describes the variation of the polarization state for a single scattering, and on the average of the iterated matrix on all possible scattering successions. A very simple formula was obtained for the average longitudinal polarization degree of the whole outgoing beam, and the final expressions were

evaluated by using the second Born approximation. Numerical values of the depolarization for aluminum and gold targets and for several values of energy and thickness are given; these values in all cases considered were never greater than a few per cent. (auth)

11956 ON THE COULOMB SCATTERING BY A SPHERICAL CHARGE DISTRIBUTION. L. Favella and E. Predazzi (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 18: 570-9(Nov. 1, 1960). (In English)

An analytic expression for the total scattering amplitude of charged particles by a static charge distribution with spherical symmetry was derived. The corresponding potential is supposed to be an arbitrary superposition of Laguerre functions. The evaluation was performed using the Coulomb point-charge waves as an approximation of first order and iterating one time in order to take into account the charge's extension. (auth)

11957 COVARIANT FORMALISM FOR PARTICLE DYNAMICS. A. Peres (Israel Inst. of Tech., Haifa) and N. Rosen. Nuovo cimento (10), 18: 644-50(Nov. 16, 1960). (In English)

In the usual covariant formulations of particle dynamics, difficulties are encountered which appear to be associated with the constraint imposed of the four-velocity, $u_k u^k = 1$. It is proposed to remove these difficulties by putting the Lagrangian into a suitable form so that this condition on the velocities is a consequence of equations of motion, together with appropriate initial conditions, rather than a constraint. (auth)

11958 PION-KAON SCATTERING. M. Gourdin (Faculte des Sciences, Orsay and Bordeaux), Y. Noirot and Ph. Salin. Nuovo cimento (10) 18: 651-70(Nov. 16, 1960). (In English)

A direct π-K interaction is proposed as being one of the possible processes responsible for K-nucleon interactions. An attempt is made at seeing if the Mandelstam representation, in the simplified and realistic form of Cini and Fubini, will allow determination of such an interaction. A general calculation technique is given for the different partial waves, and the contribution of a direct π-π interaction to the π-K scattering amplitude is given. Finally, making the hypothesis of an S-wave important, an expression is given for the latter in the approximation of the effective range, and the importance of corrections for possible π crossing is evaluated. The study of P-waves is not included. (tr-auth)

11959 A MODEL FOR DOUBLE PHOTOPRODUCTION OF CHARGED PIONS. [PART] I. D. Boccaletti and C. Guaidi (Seuola di Perfezionamento in Fisica Nucleare, Rome). Nuovo cimento (10), 18: 895-905(Dec. 1, 1960). (In English)

Double photoproduction of charged pions was studied taking into account only a diagram with only one exchanged pion. Under the assumption of a sharp pion-pion resonance in the state J = 1, T = 1, making use of an approximate solution for the invariant scattering amplitude F, the energy spectrum of the final protons was calculated at various angles. Such a theory should give at least qualitatively trustworthy results at small momentum transfers of the proton. Calculations were made in view of a possible experiment using Frascati Synchrotron 900-Mev γ rays. (auth)

11960 ON THE FERMI-YANG THEORY OF THE PIONS. K. Baumann, P. G. O. Freund, and W. Thirring (Universität, Vienna). Nuovo cimento (10), 18: 906-13(Dec. 1, 1960). (In English)

The reduction of strong interactions to the universal weak interaction, by considering them as high-energy phenomena of the strongly energy dependent weak interaction is proposed. According to Fermi and Yang the pion is assumed to be a nucleon-antinucleon bound state. A method presented previously was used to solve a Bethe-Salpeter equation. The bound state wave function was normalized, and the pion-nucleon coupling constant was calculated. The latter was found to be of the order unity although a weak interaction between the fermions was used. (auth)

11961 SOME RARE DECAY MODES OF THE K-MESON. N. Cabibbo (Universitá, Rome and Comitato Nazionale per le Ricerche Nucleari, Rome). E. Ferrari. Nuovo cimento (10), 18: 928-32(Dec. 1, 1960). (In English)

In view of future experiments with high-intensity K-meson beams the branching ratios for $K^{\pm} \rightarrow \pi^{\pm} + e^{+} + e^{-}$ and $K_1^0 \rightarrow 2\gamma$ were evaluated. (auth)

11962 EFFECT OF A PION-PION SCATTERING RESONANCE ON LOW ENERGY MESON-PHOTOPRODUCTION. M. Gourdin, D. Lurié, and A. Martin (European Organization for Nuclear Research, Geneva). Nuovo cimento (10), 18: 933-46(Dec. 1, 1960). (In English)

The influence of the two- and three-pion intermediate states in the channel $\gamma + \pi \rightarrow N + \bar{N}$ on photoproduction was studied. Application of the Cini-Fubini version of the Mandelstam representation to the amplitude $H^{(0)}$ (isoscalar photon) permitted the evaluation of the contribution of a J = I = 1 pion-pion resonance in terms of the isovector nucleon form factors and of the quantities describing the $\gamma + \pi \rightarrow \pi + \pi$ amplitude. In the limit of a very narrow resonance the result can be obtained by introducing an isovector vector boson coupled to $\gamma + \pi$ and to $N + \bar{N}$. This contribution can be merely added to the previous evaluations of $H^{(0)}$, since rescattering corrections are negligible at low energies. Arguments are given to show that the only important three-pion state is a resonant I = 0, J = 1 state which is crudely described by an isoscalar vector boson. Some of the parameters entering in this calculation can be obtained from experimental information on the isoscalar nucleon form factors. Though the three-pion contribution to $H^{(+)}$ (isovector photon) is very simple, the final result is obtained in a more complicated way because rescattering corrections are important. Through crossing, $H^{(-)}$ (isovector photon) is also affected. It seems that one of the most interesting quantities to consider, in order to compare theory and experiment, is the $d\sigma^{+}/d\sigma^{-}$ ratio and its dependence on energies and angles. (auth)

11963 ON SYMMETRIES SHARED BY STRONG AND WEAK INTERACTIONS. A. Pais (European Organization for Nuclear Research, Geneva). Nuovo cimento (10), 18: 1003-32(Dec. 1, 1960). (In English)

A recent proposal due to Treiman about global symmetry and nonleptonic decay js-coupling is discussed. An inner inconsistency of the theory is noted: $\Sigma^{+} \rightarrow n + \pi^{+}$ is forbidden in the approximation employed. This may mean that the basic symmetry assumptions of the theory have to be discarded. On the other hand, there are two possibilities to avoid the inconsistency if need be, while at the same time the predictions on nonleptonic decays are maintained. The first possibility is that the relative sign ϵ of the $\Sigma\Sigma\pi$ relative to the π-nucleon interaction = −1. The second possibility is that $\epsilon = +1$. The js-interaction is replaced by a more general one (js and jt coupling). This coupling is subjected to a parity clash condition: js and jt separately are P-conserving, but together they are P-violating. As a consequence both reactions $\Sigma^{\pm} \rightarrow n + \pi^{\pm}$ are P-conserving in the approximation of global symmetry. The clash condition is realized most simply if in the global symmetry approxima-

tion there exists only one type of S-violating current: either V or A. If it is assumed that the same S-violating currents occur in the leptonic as in the nonleptonic decays it then follows that the Ξ nucleon parity has to be odd. The concept of parity clash is shown to be incompatible with an (over-all current) × (over-all current) structure for the totality of the weak interactions. It is incompatible with the idea that a vector boson-quartet carries all weak interactions. This possibility has to stand many tests to survive. In its most natural form it allows the reactions $\Sigma^+ \rightarrow n + e^+ + \nu$ and $K^0 \rightarrow \pi^+ + e^- + \bar{\nu}$ to occur. In the simplest version of leptonic decays, the charged lepton current itself plays a role analogous to the four-vector potential in electromagnetism. All theoretical aspects of S-conserving decays remain unaffected. (auth)

11964 NEUTRON-PROTON SCATTERING AND THE DETERMINATION OF THE PION-NUCLEON COUPLING CONSTANT. R. R. Larsen (Univ. of California, Berkeley). Nuovo cimento (10), 18: 1039-42(Dec. 1, 1960). (UCRL-9398). (In English)

The pion-nucleon coupling constant, f^2, was determined from the neutron-proton charge-exchange cross section, using a method proposed by Chew. For this purpose, the neutron-proton differential cross section at 710 Mev was measured in hydrogen at 9 angles between 160 and 180°C.M. system and in deuterium at two angles within the same range. A method for the inclusion of the multiple-pion exchange removed the ambiguity in the choice of the best fit. The value of f^2 which can be used with the most confidence is 0.085 ± 0.011. (M.C.G.)

11965 MAGNETIC CONFINEMENT OF CHARGED PARTICLES. J. W. Gardner (English Electric Co., Ltd., Whetstone, Eng.). Nuovo cimento (10), 18: 1157-73 (Dec. 16, 1960). (In English)

The motion of charged particles in a cylindrical magnetic field is analyzed by a perturbation-theoretic method in which the cylindrical field is treated as a perturbation of a uniform field and is found to contain axial drift terms. These terms are evaluated to second order and used to formulate the conditions for a self-confining effect such as would be required for plasma-containment in a thermonuclear reactor. (auth)

11966 ON THE PARITY CONSERVATION IN THE REACTION $K^- + p = \Sigma^+ + \pi^-$. A. Caforio (Università, Bari, Italy), A Ferilli, D. Ferraro, M. Merlin, L. Guerriero, I. Laboragine, G. A. Salandin, F. Waldner, G. Poiani, and M. de Pretis Cagnodo. Nuovo cimento (10), 18: 1174-83 (Dec. 16, 1960). (In English)

An analysis was made of 143 protonic decays of Σ^+, emerging from K^- capture stars in nuclear emulsion, in order to detect the possible parity nonconservation in the strong capture reaction. The forward-backward asymmetry A of the decay was determined, obtaining the value A = (4.4 ± 7.8)%. This result is in accordance with the hypothesis of strict parity conservation. (auth)

11967 THE ELECTROMAGNETIC STRUCTURE AND ALTERNATIVE DECAY MODES OF THE π^0. S. M. Berman and D. A. Geffen (Univ. of Copenhagen). Nuovo cimento (10), 18: 1192-1202(Dec. 16, 1960). (In English)

It is pointed out that present experiments on the production of single Dalitz pairs in the decay of the neutral pion may yield some information about its electromagnetic structure. It is shown by means of a dispersion relation that the distribution of single Dalitz pairs in terms of the virtual photon mass is modified by a simple linear function containing only one unknown parameter, a, which would be of observable magnitude if pion intermediate states give large contributions to the dispersion relation. It is also found that, independent of any assumptions about the π^0 structure, the branching ratio for the channel $\pi^0 \rightarrow e^+ + e^-$ must be greater than $4.7 \cdot 10^{-8}$. The rate of this decay mode is surprisingly independent of the high energy behavior of the π^0 electromagnetic structure. (auth)

11968 PROTON COMPTON EFFECT. G. Bernardini (Univ. of Illinois, Urbana and CERN, Geneva), A. O. Hanson, A. C. Odian, T. Yamagata, L. B. Auerbach, and I. Filosofo. Nuovo cimento (10), 18: 1203-36(Dec. 16, 1960). (In English)

The elastic scattering of photons by protons was measured for 100- to 290-Mev photons at 90 and 139° c.m.s. scattering angles. The expected large increase in cross section is observed at energies approaching that of $(^3/_2, ^3/_2)$ pion-nucleon resonance. The scattering can be qualitatively explained by the ordinary Thomson amplitude combined with that of the $(^3/_2, ^3/_2)$ resonance. A more detailed examination of the cross section in the region just above the photo-meson threshold has shown that it is sensitive to the π^0 photon coupling. From the experimental data, a conclusion may be made that the π^0 mean life should be between 10^{-16} and 10^{-18} sec. (auth)

11969 PION-PION INTERACTION FROM π PRODUCTION IN πN COLLISION. F. Bonsignori, V. Bortolani, and A. Stanghellini (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10), 18: 1237-46(Dec. 16, 1960). (In English)

The Chew and Low model for the determination of the $\pi\pi$ cross section is used for the analysis of an experiment of pion production by pions. The one-pion-exchange model and the possible $\pi\pi$ resonances are discussed. (auth)

11970 ENERGY GAP IN THE SPECTRUM OF FREE QUASI-PARTICLES IN NUCLEAR MATTER. G. Fano and A. Tomasini (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10), 18: 1247-57(Dec. 16, 1960). (In English)

A sufficient condition is given for the existence of an energy gap in the spectrum of free quasi-particles in nuclear matter, assuming a finite repulsive potential inside the core. (auth)

11971 RELATION BETWEEN π-N SCATTERING AND NUCLEON STRUCTURE THROUGH $\pi\pi$ INTERACTION. A. Stanghellini (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo cimento (10), 18: 1258-64(Dec. 16, 1960). (In English)

The relation between long-range effects in pion-nucleon scattering and nucleon structure through pion-pion interaction in T = 1, J = 1 state is analyzed by means of different models. (auth)

11972 PRELIMINARY RESULTS OF A MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR SINGLE π^0 MESON PHOTOPRODUCTION IN HYDROGEN. G. Cortellessa and A. Reale (Instituto Superiore di Sanità, Rome). Nuovo cimento (10), 18: 1265-6(Dec. 16, 1960). (In English)

A study was made to determine if the discrepancies at the second resonance (500 to 900 Mev) in π^0 photoproduction in hydrogen are due to lack of angular and energy resolution. Single π^0 photoproduction was detected by a coincidence between the recoil proton and one of the γ rays from decay of the π^0. The results correspond to a 56° c.m.s. angle for the π^0, and the first conclusion is that the peak of the differential cross section is at a laboratory energy of ~700 Mev and has a resonance width of the order of 50 Mev. Measurements for other c.m.s. angles will allow a more complete analysis. (T.R.H.)

11973 A NOTE ON THE FERMI-TELLER "Z-LAW". A. Astbury, P. M. Hattersley, M. Hussain, M. A. R. Kemp, and H. Muirhead (Univ. of Liverpool). Nuovo cimento (10), 18: 1267-8(Dec. 16, 1960). (In English)

The Fermi-Teller Z-law suggests that when μ^- mesons are brought to rest in a compound, the atomic capture probability C for an element of charge Z and N atoms/cm^3 should be proportional to NZ. In an experiment with PbF_2 using the Liverpool synchrocyclotron, a value of 4.8 ± 0.7 was obtained for the atomic capture probability ratio C_{Pb}/C_F. The Z-law predicts a value of 4.5; if C varied according to atomic concentration, a value of 0.5 would be expected. (T.R.H.)

11974 ON A MODEL FOR Ξ DECAYS. A. P. Balachandran and N. R. Ranganathan (Univ. of Madras). Nuovo cimento (10), 18: 1269-70(Dec. 16, 1960). (In English)

The consequences of treating a Ξ hyperon as a bound state of a Λ^0 and a $\overline{K}$ on $\overline{K}$ decay modes are discussed. The case is considered where the parity of the $(\Lambda^0\overline{K})$ system relative to the $\overline{K}$-hyperon is even. (T.R.H.)

11975 EXAMPLE OF TWO MESONS' PRODUCTION IN K^- STARS AT REST. S. Mora (Università, Parma, Italy). Nuovo cimento (10), 18: 1271-3(Dec. 16, 1960). (In English)

During analysis of 4500 K^- stars at rest, an event with two mesons of opposite charge was found. A proton and a recoil 3 μm long, opposite the proton, were also found. A first interpretation assumes that both mesons are emitted in a fast process: $K^- + p \rightarrow \pi^+ + \pi^- + \Lambda^0 + 38$ Mev. A second interpretation is based on the assumption of successive emission of the two mesons, one in a fast process, the other in a slow process. (T.R.H.)

11976 THE MOST PROBABLE PATH OF A SCATTERED PARTICLE. N. C. Barford (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 18: 1274-6(Dec. 16, 1960). (In English)

A graphical method for determining the most probable path of a particle through a plate of scattering material has been described by Barford and Reynolds (Nuovo cimento, 4: 929(1956)). A generalization of the theory involved is offered which allows a more complete solution and eliminates the need for graphical construction. (T.R.H.)

11977 ELECTROPRODUCTION OF SCHIZONS. P. Budini and G. Furlan (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo cimento (10), 18: 1280-2(Dec. 16, 1960). (In English)

The electroproduction of schizons is studied as a process which presents a favorable situation for answering the problem of the existence of an intermediate boson field as a transmitter of the weak interactions. (T.R.H.)

11978 SEARCH FOR ELECTRONS FROM MUON CAPTURE. M. Conversi, L. di Lella, A. Egidi, C. Rubbia, and M. Toller (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo cimento (10), 18: 1283-6(Dec. 16, 1960). (In English)

Experiments were performed to show the existence of the processes $\mu^- + p \rightarrow p + e^-$ or $\mu^- + n \rightarrow n + e^-$ if the branching ratio (R = rate of $\mu^+ + Cu \rightarrow Cu + e^-$/rate of $\mu^- + Cu \rightarrow Ni + \nu$) was larger than a few times 10^{-6}. The 60-Mev muon beam at CERN was used with 12 plastic scintillators in an electron telescope which had a detection efficiency of 0.14 for 8-fold coincidences. A value of $R < 5.9 \times 10^{-6}$ with 90% confidence level was found, in agreement with that found by Sard et al., using a different technique. (T.R.H.)

11979 A NOTE CONCERNING THE MAGNETIC MOMENT OF THE MUON. N. Byers and F. Zachariasen (Stanford Univ., Calif.). Nuovo cimento (10), 18: 1289-90 (Dec. 16, 1960). (In English)

In view of the recent interest in the existence of a vector boson (χ) intermediary for the weak interactions, a calculation was made of the effect of such a particle on the magnetic moment of the muon. A dispersion relation for the vertex $\gamma \rightarrow \mu^+ + \mu^-$, the interesting quantity, was used. The result obtained was, if the neutrinos in β decay and μ decay are identical, $\mu_\chi = (e/2m_\mu)\sqrt{\rho}\ 8.4 \times 10^{-6}$ where ρ is the branching ratio for $\mu \rightarrow e + \gamma$. If the neutrinos are not identical, ($\mu \rightarrow e + \gamma$ forbidden) then $\mu_\chi = (e/2m_\mu)(gm_\mu/M_\chi)^2\ (I/32\pi^2)$, where I is the divergent integral which, if cut off at Λ^2, is approximately equal to $\ln(\Lambda/2M_\chi)$ if $\Lambda^2 \gg m_\mu^2$; g is the $\chi\mu\nu$ coupling constant ($G = g^2/M_\chi^2$). (T.R.H.)

11980 THE EXCITED HYPERON AND PION-HYPERON RESONANCES. S. F. Tuan (Brown Univ., Providence). Nuovo cimento (10), 18: 1301-4(Dec. 16, 1960). (In English)

Recently Good, in a study of momentum spectra for π^+ and π^- in $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ at K^- lab momentum 1.15 Bev/c, reported the existence of an excited hyperon Y^* in the I = 1 state, strongly produced, and of mass 1370 ± 25 Mev. The Good resonance is discussed qualitatively in terms of zero effective range theory or the so-called scattering length approximation. (T.R.H.)

11981 ANALYTIC PROPERTIES OF SINGLE-PARTICLE PROPAGATORS FOR MANY-FERMION SYSTEMS. J. M. Luttinger (Columbia Univ., New York). Phys. Rev., 121: 942-9(Feb. 15, 1961).

Certain general properties of single-particle propagators for a system of interacting fermions are derived. The properties of the proper self-energy part $G_k(\xi)$ which were used in previous work on the ground-state energy and on the Fermi surface are also established. In particular, the fact that to all orders of perturbation theory in the interaction, Im $G_k(x - i0^+)$ behaves like $C_k(x - \mu)^2$ ($C_k > 0$) for x very near μ, is proved. (auth)

11982 PERTURBATION THEORY FOR AN INFINITE MEDIUM OF FERMIONS. [PART] II. Abraham Klein (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 121: 950-6(Feb. 15, 1961).

New forms of the linked cluster expansion for the ground-state energy of a normal spherical system are given in terms of the exact single-particle propagator and of the associated self-energy operator. These forms are shown to be stationary with respect to variations of the latter quantities. A new concise proof of the Hugenholtz-Van Hove theorem on single-particle energies is then possible. The variational principle also explains the insensitivity of recent binding energy calculations to the choice of single-particle energies. It is shown how all results may be extended to systems with anisotropic features. (auth)

11983 PERTURBATION THEORY FOR AN INFINITE MEDIUM OF FERMIONS. III. DERIVATION OF THE LANDAU THEORY OF FERMI LIQUIDS. Abraham Klein (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 121: 957-61(Feb. 15, 1961).

The methods employed for determining the ground-state energy of a normal Fermion system are extended to finite temperatures. The basic assumption is that the density matrix of the actual system in thermodynamic equilibrium can be derived by adiabatic transformation from the density matrix of a system of noninteracting particles at the same temperature, volume, and chemical potential. However, the spectrum of the noninteracting system must be dependent on

the intensive parameters. The self-consistency of the scheme is exhibited by demonstrating that the effective potential characterizing this system can be related to the self-energy operator of the actual system. Two equivalent versions of the theory are derived. In one of these the basic equations are precisely those of the Landau theory of Fermi liquids with the difference, however, that all quantities are given explicitly from first principles. (auth)

11984 OPTICAL-MODEL ANALYSIS OF LOW-ENERGY ELECTRON-HYDROGEN SCATTERING. B. A. Lippmann and H. M. Schey (Univ. of California, Livermore). Phys. Rev., 121: 1112-23(Feb. 15, 1961). (UCRL-6111)

The electron-hydrogen scattering problem is reduced to an equivalent one-body problem by the use of an optical-model potential. Two effects were examined quantitatively: the influence of the Pauli principle and the elastic scattering in the triplet state. For a long-range optical potential, the effect of the Pauli principle was small; however, for a short-range optical potential, the Pauli principle changed the zero-energy cross section by an order of magnitude. The elastic scattering results were disappointing; it was argued that this is due to an inconsistent application of the optical model. (auth)

11985 MEASUREMENT OF DEUTERON POLARIZATION PRODUCED BY d-α SCATTERING AT 1.07 MEV. Lee G. Pondrom and J. W. Daughtry (Aeronautical Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 121: 1192-4(Feb. 15, 1961).

Elastic scattering from He^4 gas in the energy region of the 1.07-Mev resonance was used to polarize deuterons. After scattering through 30° in the lab by the polarizer, the polarization of the deuteron beam was analyzed by the reaction $He^3(d,p)He^4$ near 400 kev. This was accomplished by observing protons at 0 and 90°, and measuring the dependence of the counting rate ratio on the deuteron polarization. $He^3(d,p)He^4$ is well described in this energy region by a single-level Breit-Wigner formula, and therefore has a predictable sensitivity to deuteron polarization. (auth)

11986 NEUTRAL LEPTON CURRENTS AND NEUTRINO DETECTION. R. W. King (Purdue Univ., Lafayette, Ind.). Phys. Rev., 121: 1201(Feb. 15, 1961).

The interactions of neutrinos with complex nuclei are explored assuming the existence of a neutral lepton current. (auth)

11987 INELASTIC SCATTERING OF A Σ-HYPERON WITH AN EMULSION NUCLEUS. H. E. Fisk and D. J. Prowse (Univ. of California, Los Angeles). Phys. Rev., 121: 1202-4(Feb. 15, 1961).

In a systematic study of fast hyperons resulting from the nuclear capture of K^- mesons, an event was found which is interpreted as the elastic scattering of Σ^- hyperon by a bound neutron. The reaction kinematics are insufficient to determine the nature of the nuclear potential for Σ^- hyperons but it appears that when about 10 of these events have been found and analyzed, it will be possible to infer the sign of the potential from the general effect it will have on the observable kinematics of the events. (auth)

11988 DEMONSTRATION OF QUANTUM MECHANICS IN THE LARGE. T. B. Day (Univ. of Maryland, College Park). Phys. Rev., 121: 1204-6(Feb. 15, 1961).

An example is given which demonstrates in a straightforward and dramatic manner that when two particles like $(K^0 + \overline{K}^0)$ or (2γ) are created simultaneously, the probabilities involved in observing any further events related to their simultaneous creation must be calculated quantum mechanically and are correlated, even for macroscopic distances in absorbing media. In particular, a correlation in the polarization of the two γ rays from positronium annihilation as a function of the thickness of magnetized iron through which they are passed is proposed as an experiment. (auth)

11989 ASYMMETRY IN 143-MEV pn SCATTERING. Arthur F. Kuckes and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev., 121: 1226-8(Feb. 15, 1961).

A beam of 145-Mev protons of polarization 69 ± 2% was scattered from liquid deuterium. pn scattering events were identified by a coincidence method. The asymmetry in the scattering was measured. These data can be compared with polarization in free np scattering at the appropriate angles. (auth)

11990 ELASTIC SCATTERING OF 146-MEV POLARIZED PROTONS BY DEUTERONS. Herman Postma and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev., 121: 1229-44(Feb. 15, 1961).

The polarization and differential cross section of 146-Mev protons elastically scattered by deuterons were measured in the center-of-mass angular range from 3.9 to 170°. A description of the liquid deuterium target and detection apparatus which permitted the measurement of the elastic events over these angles is given. At small angles the proton was energy analyzed; at large angles the recoil partner of the proton, the deuteron, was identified and energy analyzed. Although the energy resolution of ±1.7 Mev and the angular resolution of ±2.0° were sufficient to separate quasi-elastic events from elastic events at most angles, they were insufficient to resolve unambiguously the 2.3-Mev inelastic events resulting from the formation of virtual deuterons. (auth)

11991 MODEL OF HYPERON DECAY. L. Wolfenstein (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 121: 1245-6(Feb. 15, 1961).

The vanishing of the asymmetries in the decays $\Sigma^- \rightarrow n + \pi^-$ and $\Sigma^+ \rightarrow n + \pi^+$ are explained in a model in which all Σ decays occur via virtual K-meson decays. The model then predicts a Λ-decay asymmetry of similar magnitude but opposite sign to that of $\Sigma^+ \rightarrow p + \pi^0$. Certain other predictions of this model are discussed. (auth)

11992 DEUTERON ELECTRIC QUADRUPOLE MOMENT. J. P. Auffray (New York Univ., New York). Phys. Rev. Letters, 6: 120(Feb. 1, 1961).

The deuteron electric quadrupole moment Q is calculated by deriving theoretically the electric field gradient q along the molecular axis at one deuteron for the quadrupole coupling constant eQq. With the use of a trial molecular wave function constructed in the framework of the Born-Oppenheimer approximation which gives a molecular binding energy of 4.728 ev, Q is calculated to be 2.82×10^{-27} cm^2, about 3% larger than Newell's Q value. (D.L.C.)

11993 POSSIBLE EXISTENCE OF A NEW K′ MESON. J. Tiomno, A. L. L. Videira, and N. Zagury (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro and Universidade, Rio de Janeiro). Phys. Rev. Letters, 6: 120-3 (Feb. 1, 1961).

The $p + \pi^- \rightarrow K^0 + \Lambda$ reaction, in which Λ particles are strongly peaked backward in the c.m. system, is treated on the basis of the Pais scheme. The existence of a K′ meson identical to ordinary K mesons but of opposite parity is assumed, and the intermediate χ^+ in the reaction is taken to be K'^+ instead of K^+ as in the original Pais scheme. The differential cross section is calculated by using the Born approximation and the μ value determined which gives the

best fit to experimental data. The most probable μ value was found to be 605 ± 49 Mev, where K′ is scalar. The fit of the experimental data on the angular distribution of Λ is good except where cos $\theta \sim 1$. The results indicate that the K′ meson should have a mass $\mu \geq m_K + m_\pi$ and should be short lived. Other possibilities are discussed. (D.L.C.)

11994 MEASUREMENT OF THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. G. Charpak, F. J. M. Farley, R. L. Garwin, T. Muller, J. C. Sens, V. L. Telegdi, and A. Zichichi (European Organization for Nuclear Research, Geneva). Phys. Rev. Letters, 6: 128-32(Feb. 1, 1961).

The anomalous magnetic moment of the muon was measured directly by storing polarized muons in a magnetic field for as long as 1000 cyclotron periods. The anomalous moment, $a = (g-2)/2$, was found to be $a_{exp} = a_{th}(0.983 \pm 0.019) = 0.001145 \pm 0.000022$, where a_{th} is the anomalous moment expected from the quantum electrodynamics of a Dirac particle. Interpretations of this good agreement between theory and experiment are given. (D.L.C.)

11995 ELASTIC SCATTERING OF LOW-ENERGY K^- MESONS ON PROTONS. D. H. Davis (University Coll., London), R. D. Hill, B. D. Jones, B. Sanjeevaiah, J. Zakrzewski, and J. P. Lagnaux. Phys. Rev. Letters, 6: 132-4 (Feb. 1, 1961).

Low-energy K^--p elastic scattering events in bubble chambers and emulsions are studied in order to investigate the possibility of a peak at ~30 Mev. The results indicate that the scattering cross section is increasing in the region of lowest K^- meson momentum and that there is only ~10% probability that the cross section will flatten off at momenta lower than 120 Mev/c. Possible explanations are offered for the cross-section flattening observed in earlier emulsion experiments. (D.L.C.)

11996 Ξ^- PRODUCTION BY K^- MESONS. William B. Fowler, Robert W. Birge, Philippe Eberhard, Robert Ely, Myron L. Good, Wilson M. Powell, and Harold K. Ticho (Univ. of California, Berkeley). Phys. Rev. Letters, 6: 134-6(Feb. 1, 1961).

A 30-in. propane chamber was operated in a 1.17-Bev/c K^- beam to produce cascade particles, and 100,000 pictures were taken. Eighteen negative cascade decays with decay mode $\Xi^- \rightarrow \Lambda + \pi^-$ were identified, of which six were produced with a K^+ meson and three were accompanied by a visible θ_1 decay. Three of the events with a K^+ satisfy the kinematics for $K^- + p \rightarrow \Xi^- + K^+$, whereas the other three are assumed to be produced from protons in carbon. The average mass of Ξ^- for these 18 events was found to be 1317.9 ± 1.9 Mev, and the mean life was determined to be 1.28×10^{-10} sec. The decay asymmetry parameter, α_Ξ, was determined to be 0.69 ± 0.36, and $\alpha_\Xi \overline{P} = -0.28 \pm 0.40$, where $\overline{P}$ is the polarization of Ξ^- produced in $K^- + N \rightarrow \Xi^- + K$. The Ξ^- production cross section in $K^- + N \rightarrow \Xi^- + K$ is estimated to be 18 ± 5 μb/nucleon. (D.L.C.)

11997 TEST FOR PION-PION RESONANCE. G. Pinski (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 6: 136-8(Feb. 1, 1961).

The possibility of using a decay mode as a test for π-π resonance is examined in terms of statistical theory. The annihilation $\overline{p} + n \rightarrow \pi^- + \pi^- + \pi^+$ should be ideal for detecting π-π resonances, particularly in the (+ −) correlation. Some pion mass squared distributions are shown for the $\overline{p}$ + n reaction. (D.L.C.)

11998 TWO-PION EXCHANGE INTERACTION. G. Breit, K. E. Lassila, H. M. Ruppel, and M. H. Hull, Jr. (Yale Univ., New Haven). Phys. Rev. Letters, 6: 138-41 (Feb. 1, 1961).

Comparisons of Gupta's two-pion-exchange potential with the one-pion-exchange potential were made by using dispersion relations. Tables are presented for the combined effects of V_2 and V_4 (second and fourth order potentials) and one-pion and two-pion exchange effects for YLAM (T = 1) and YLAN3M (T = 0). (D.L.C.)

11999 INFLUENCE OF THE $\Lambda\ \pi$ RESONANCE ON CORRELATIONS IN THE REACTION $K^- + d \rightarrow \Lambda + \pi^- + p$. Orin I. Dahl, Nahmin Horwitz, Donald H. Miller, Joseph J. Murray, and Paul G. White (Univ. of California, Berkeley). Phys. Rev. Letters, 6: 142-4(Feb. 1, 1961). (UCRL-9514)

A 15-in. deuterium bubble chamber was exposed to a 450-Mev/c separated K^- beam, and a group of events were examined corresponding to $K^- + d \rightarrow \Lambda + \pi^- + p$ and $K^- + d \rightarrow \Sigma^0 + \pi^- + p$, $\Sigma^0 \rightarrow \Lambda + \gamma$. The distribution of proton and pion energies and their spectra are given. Two peaks appear in the pion spectrum at 92 and 147 Mev; the 92-Mev peak agrees well with that calculated on the basis of $\Sigma\Lambda$ conversion and the zero-effective-range theory for the S-wave interaction. The assumption of a $\Lambda\pi$ resonance of total mass of 1382 Mev and half width of ±20 Mev gives a proton spectral peak near 30.5 Mev, in agreement with experiment. The contributions of direct production and conversion to the proton spectrum are also shown. The region of proton energies 5 to 20 Mev, where $\Sigma\Lambda$ conversion is negligible, is considered. Finally, the interactions are compared with the nonmesonic processes $K^- + d \rightarrow \Sigma^- + p$, $\Sigma^0 + n$, or $\Lambda + n$. (D.L.C.)

12000 K-π RESONANCE AND LIFETIME OF THE K′ PARTICLE. Mirza A. Baqi Bég and Paul C. De Celles (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 6: 145-6(Feb. 1, 1961).

Equations are given for K′ (a scalar isobaric doublet) or K_v (a vector particle) production in K-p scattering in terms of its lifetime and spin. The total cross sections calculated from the πK resonance energy of 878 Mev, are $\sigma = 1.9/(\tau_s \times 10^{23})$ mb for K′ and $24/(\tau_v \times 10^{23})$ mb for K_v, where τ_s and τ_v are the lifetimes of the respective particles in seconds. The angular distributions of the recoil protons for both cases are plotted on a graph which indicates that a pronounced backward peaking of the protons would be strong evidence for K′. For K′, $1.34 < \tau_s \times 10^{23} < 3.28$, whereas, for K_v, $16.9 < \tau_v \times 10^{23} < 41.4$; therefore, the experimental value $2.38 < (1/\Gamma) \times 10^{23} < 3.58$ supports the K′ alternative. The limitations of the calculations are discussed. (D.L.C.)

12001 DIRECT Ξ DECAY AND MUONIUM–ANTIMUONIUM TRANSITIONS. Sheldon Lee Glashow (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 6: 196-7(Feb. 15, 1961).

The effects of a mass difference due to $\Delta S = 2$ weak interactions on Ξ decay are discussed, along with muonium-antimuonium transitions in $e^- + e^- \rightarrow \mu^- + \mu^-$ interactions. (D.L.C.)

12002 PION PHOTOPRODUCTION AT BACKWARD ANGLES NEAR THE SECOND NUCLEON-PION RESONANCE. L. Hand and C. Schaerf (Stanford Univ., Stanford, Calif.). Phys. Rev. Letters 6: 229-31(Mar. 1, 1961).

An experiment is described in which photons with energies of 500 to 820 Mev strike a liquid hydrogen target. The center-of-mass differential cross sections for π^+ photoproduction from the hydrogen are measured at laboratory angles of 135 and 180° for various photon energies. Differences between the photoproduction resonance peaks and π^--p total cross sections are discussed, and conclusions are suggested as to the existence of a $T = \frac{1}{2}$ resonant state in the pion-nucleon interaction about 320 Mev center-of-mass above the $J = \frac{3}{2}$, $T = \frac{3}{2}$ resonance. (T.F.H.)

12003 ELASTIC AND QUASI-ELASTIC COLLISIONS OF PROTONS WITH MOMENTA BETWEEN 9 AND 25 Gev/c. G. Cocconi, A. N. Diddens, E. Lillethun, and A. M. Wetherell (European Organization for Nuclear Research, Geneva). Phys. Rev. Letters 6: 231-4(Mar. 1, 1961).

There is evidence that ultrarelativistic cosmic-ray nucleons often emerge from interactions with nucleons at rest with little loss of energy, i.e., they undergo "quasi-elastic" interactions. An experiment is described in which monochromatic proton beams, with momenta from 9 to 25 Gev/c, strike a beryllium target; protons produced are momentum analyzed, and it is found that the differential scattering cross sections exhibit two peaks, corresponding to elastic and quasi-elastic collisions, for each value of incident proton momentum. It is postulated that the elastic peaks results from proton diffraction scattering of individual nucleons, and that the quasi-elastic peak results from diffraction disintegration of nucleons by the ultrarelativistic protons. (T.F.H.)

12004 SEARCH FOR THE ω^0 IN PHOTOPRODUCTION. K. Berkelman, G. Cortellessa, and A. Reale (Istituto Superiore di Sanità, Rome). Phys. Rev. Letters 6: 234-6 (Mar. 1, 1961).

An anomalous peak is found in the He^3 recoil momentum spectrum in the bombardment of deuterons with protons; this peak can be associated with either a two-pion resonant state or a particle (arbitrarily named the ω^0 meson) of mass ~310 Mev. An experiment is described in which photoproduction of the ω^0 is attempted in liquid hydrogen. No evidence of the ω^0 is found with a pion telescope. It is suggested that the ω^0 might decay by means other than pion pair-production; that it might have an anomalously small photoproduction cross section; or that it might be a long-lived particle. (T.F.H.)

12005 PION-PION INTERACTION AND HIGH-ENERGY p + d COLLISIONS. J. G. Taylor (Faculté des Sciences, Orsay, France and Institut des Hautes Etudes Scientifiques, Paris). Phys. Rev. Letters 6: 237-8(Mar. 1, 1961).

The anomaly in meson production in proton-deuteron collisions is examined, and theoretical evidence is presented that the anomaly is an S and P wave pion-pion interaction. This conclusion is based on the crossing symmetry equations for pion-pion scattering and on asymmetry evidence in the pion-momentum spectrum in τ decay. (T.F.H.)

12006 $\bar{K}$-NUCLEON BOUND-STATE INTERPRETATION OF THE 1385-Mev $\pi-\Lambda$ RESONANCE. R. H. Dalitz (Univ. of California, Berkeley). Phys. Rev. Letters 6: 239-41(Mar. 1, 1961). (UCRL-9543)

The possibility is pointed out that pion-hyperon (Y) resonances might be associated with bound states of anti-K-meson ($\bar{K}$)- nucleon (N) systems. The conditions for such correlation between π-Y and $\bar{K}-N$ systems are derived. (T.F.H.)

12007 PARTITION FUNCTIONS AS AVERAGES OF FUNCTIONALS OF GAUSSIAN RANDOM FUNCTIONS. A. J. F. Siegert (Northwestern Univ., Evanston, Ill.). Physica, 26: Suppl., S30-5(Dec. 1960). (In English)

It is shown that the grand partition function for a system of interacting particles can be obtained by a method which entirely bypasses the second quantization formalism. Equations were determined for the coordinate representation of the density matrix with Born-von Karman conditions for particles with Boltzmann statistics. The equations for the canonical and grand canonical partition functions were derived for particles with Boltzmann, Bose, and Fermi statistics. (M.C.G.)

12008 IMPERFECT BOSE SYSTEM. C. N. Yang (Inst. for Advanced Study, Princeton, N. J.). Physica, 26: Suppl., S49-57(Dec. 1960). (In English)

Work on the dilute hard sphere Bose system and on a method of treating Bose condensation in a general interacting system is summarized. The topics discussed include the ground-state energy, excited energy states, equilibrium and nonequilibrium thermodynamical properties, superfluid flow, and the density matrix. (M.C.G.)

12009 BOSE-EINSTEIN SYSTEM WITH ATTRACTIVE FORCES. Kerson Huang (Massachusetts Inst. of Tech., Cambridge). Physica, 26: Suppl., S58-61(Dec. 1960). (In English)

A Bose system of N particles, contained in a periodic box and interacting via a two-body potential which contains a hard core plus a weak long-ranged attractive potential, was considered. The energy levels and equation of state of the system were calculated. (M.C.G.)

12010 ON THE THEORY OF IMPERFECT FERMI GASES. Claude Block (Centre d'Études Nucléaires, Saclay, France). Physica, 26: Suppl., S62-74(Dec. 1960). (In English)

Some of the expansions of the Gibbs potential, proposed for systems of interacting fermions, are described. Only the perturbation method is considered in the calculation of the Gibbs potential at nonzero temperatures. The case of strong interactions can be treated within this framework by introducing the partial summation of the ladder diagrams at each interaction. Other transformations of the perturbation expansion of the potential which were motivated essentially by the study of its zero temperature limit are described. It was found that the explicit result of Goldstone is obtained only in the isotropic case. The problem of the zero temperature limit showed the importance of the diagrams containing self energy parts. The most general decomposition of a vacuum-vacuum diagram into proper parts leads to a topological structure having the form of a tree of necklaces of bubbles. Each bubble can be taken as the skeleton of the diagram of the complete propagator. (M.C.G.)

12011 ON THE CLASSICAL LIMIT OF THE DIAGRAM EXPANSION IN QUANTUM STATISTICS. T. W. J. M. Janssen (Rijksuniversiteit, Utrecht). Physica, 26: Suppl., S75-7(Dec. 1960). (In English)

The way in which the quantum statistical diagram expression, as given by Lee and Yang, in the classical limit tends to the Mayer diagram expansion is demonstrated. It was also verified that the connected Lee-Yang diagrams correspond to the connected Mayer diagrams. (M.C.G.)

12012 RELATIONS INVOLVING THE FORWARD SCATTERING AMPLITUDE IN A FERMI GAS. B. A. Jacobsohn (Rijksuniversiteit, Utrecht and CERN, Geneva). Physica, 26: Suppl., S78-80(Dec. 1960). (In English)

Several exact relationships are given for the ground state of a Fermi gas with interaction. These involve the two-particle forward scattering amplitude and the effective mass at the Fermi surface. (auth)

12013 THERMODYNAMICAL VARIABLES IN TERMS OF DISTRIBUTION FUNCTIONS OF QUASI-PARTICLES. C. De Dominicis (Centre d'Études Nucléaires, Saclay, France). Physica, 26: Suppl., S94-101(Dec. 1960). (In English)

Thermodynamical quantities for a quantum mechanical system of interacting particles were derived in terms of distribution functions for "quasi-particles" for all temperatures. Results were obtained by perturbation and resummation methods. All possible Goldstone-like diagrams were drawn in the time-independent formulation. (M.C.G.)

12014 RELATION BETWEEN MANY-BODY AND SINGLE-PARTICLE ASPECTS IN NUCLEI. G. E. Brown and D. J. Thouless (Univ. of Birmingham, Eng.). Physica, 26: Suppl., S145-54(Dec. 1960). (In English)

The process by which certain types of collective excitations in nuclei are built up from single-particle excitations through the nucleon-nucleon interaction is described. Analogies in the methods used to those employed in describing other Fermi systems are shown. Among the types of collective excitations are the dipole state and vibrational motion. A schematic model formulated in the language of the many-body theory and designed to handle the main qualitative features of a finite system is described. It was found that taking ground-state correlations meant doubling the order of the matrix in shell-model calculations. The ground-state correlations enhanced the transition probability for vibrational states where $E \ll \epsilon$ and cut it dow.i for plasma oscillations. (M.C.G.)

12015 A NEW APPROACH TO THE MANY BODY PROBLEM, IN PARTICULAR TO THE THEORY OF THE ELECTRON GAS. Nobuyuki Fukuda (Tokyo Univ. of Education). Physica, 26: Suppl., S162-9(Dec. 1960). (In English)

Recent developments in many-body problems are discussed. The solutions of an electron gas at high density, which take into account the correlations leading to the plasma oscillation and the screening of the Coulomb interaction, were taken as the starting point for generalizing the theory of an electron gas at high density. The unitary transformation, which diagonalizes the hamiltonian of the meson pair theory, was obtained. Since this theory is equivalent to the theory of an electron gas at high temperature, a complete set of eigenfunctions could then be obtained. (M.C.G.)

12016 GROUND STATE OF A SYSTEM OF INTERACTING BOSONS. N. M. Hugenholtz (Inst. for Advanced Study, Princeton, N. J. and Brookhaven National Lab., Upton, N. Y.). Physica, 26: Suppl., S170-3(Dec. 1960). (In English)

The difficulty encountered in the use of field theory methods for a system of bosons is discussed. For the case of weakly interacting bosons this difficulty was resolved by Bogoliubov. By extending his argument it is shown that to all orders the condensed phase may be eliminated and replaced by an external field of frequency μ, where μ is the chemical potential. (M.C.G.)

12017 COLLECTIVE EXCITATIONS IN FERMI SYSTEMS. V. M. Galitsky. Physica, 26: Suppl., S174-80 (Dec. 1960). (In English)

Collective excitations in Fermi systems at zero temperature are discussed. The problem of investigating collective excitations reduces to a consideration of the two-particle Green's function and to finding the isolated poles of this function. The solution of the problem is different for the two cases of repulsion and attraction between particles. In the case of repulsion, the collective excitations represent either zero sound or plasma waves. For the case of attraction at small momenta, ordinary sound was obtained. The formation of coupled pairs makes it impossible for the sound quantum to decay into excitations. (M.C.G.)

12018 TWO REMARKS ON THE THEORY OF THE FERMI GAS. Leon Van Hove (Rijksuniversiteit, Utrecht). Physica, 26: Suppl., S200-3(Dec. 1960). (In English)

The Cooper pair problem and the applicability of perturbation theory to the ground state of an imperfect Fermi gas were investigated. The results, a consequence of the sharp edge in the momentum distribution of the ideal gas, suggested that for an imperfect Fermi gas with attractive forces the ground state is not obtainable from perturbation theory, in the ground state there is no discontinuity in the momentum distribution, or the ground state of a gas of N particles can be approximated by a self-consistent superposition of N/2 bound pairs of the type suggested by Cooper. The convergence of a simple example of linked cluster expansion was also investigated. It was found that the separation of diagrams in connected components artificially reduced the convergence radius. (M.C.G.)

12019 EFFECTS OF SCREENING AND MULTIPLE SCATTERING OF THE PRIMARY ELECTRON ON THE POLARISATION OF BREMSSTRAHLUNG. Haridas Banerjee (Indian Inst. of Tech., Kharagpur). Proc. Natl. Inst. Sci. India. Pt. A, 26: 681-6(Nov. 26, 1960). (In English)

It is shown that the effects of screening on the Bremsstrahlung cross section can be considered without referring to any particular atomic form factor. Explicit expressions for the polarization-dependent cross sections were obtained on the assumption of exponential screening. The intrinsic energy-angle distribution of the Bremsstrahlung thus obtained was then combined with Moliere's theory of multiple scattering for the primary electrons. It was found that at least for forward emission, the energy dependence of the polarization of Bremsstrahlung is hardly affected by the considerations of multiple scattering. (auth)

12020 SHADOW EFFECT IN THE SCATTERING OF GEV PIONS AND NUCLEONS BY DEUTERONS. B. Dejon (Brookhaven National Lab., Upton, N. Y.) and K. Smith. Proc. Phys. Soc. (London), 76: 346-8(1960). (BNL-4463).

The experimental total cross sections for the individual pion–nucleon and nucleon–nucleon processes have been used to deduce the pion–deuteron and nucleon–deuteron total cross sections by using a geometrical optic model. (auth)

12021 DIAMAGNETISM OF MANY-FERMION SYSTEMS. G. L. Sewell (The University, Liverpool). Proc. Phys. Soc. (London), 77: 136-46(Jan. 1, 1961).

A set of simple theoretical criteria was established for the occurrence of the Meissner effect in a many-electron system. The criteria are of a qualitative nature and involve only the single- and two-particle excitations of the system. (auth)

12022 A NON-LINEAR FIELD THEORY. T. H. R. Skyrme (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London) A, 260: 127-38 (Feb. 7, 1961).

A unified field theory of mesons and their particle sources is proposed and considered in its classical aspects. The theory has static solutions of a singular nature, but finite energy, characterized by spin directions; the number of such entities is a rigorously conserved constant of motion; they interact with an external meson field through a derivative type coupling with the spins, akin to the formalism of strong-coupling meson theory. There is a conserved current identifiable with isobaric spin, and another that may be related to hypercharge. The postulates include one constant of the dimensions of length, and another that is conjectured necessarily to have the value $\hbar c$, or perhaps $\frac{1}{2}\hbar c$, in the quantized theory. (auth)

12023 ENERGY SPECTRUM AND SCATTERING PROBLEM IN QUANTIZED FIELD THEORY. Shûkô Azuma (Fukusima Univ., Japan). Progr. Theoret. Phys. (Kyoto), 24: 689-720(Oct. 1960). (In English)

It is shown that the scattering problem can be formulated in terms of a generating operator with respect to the varia-

tion of the coupling parameter which is contained in the Hamiltonian. This formalism makes possible the rigorous treatment of problems concerning the self energies of closed systems as well as the scattering between bound states. A certain general relation can be obtained concerning the phase shifts and levels, which includes the field theoretical generalization of Levinson's theorem. (auth)

12024 INTERNAL QUANTUM STATES OF HYPERSPHERICAL (NAKANO) RELATIVISTIC ROTATORS. D. Bohm (Bristol Univ., Eng.), P. Hillion, and J. P. Vigier. Progr. Theoret. Phys. (Kyoto), 24: 761-82(Oct. 1960). (In English)

If one quantizes with conventional methods the classical internal motion of the hyperspherical (Nakano) relativistic rotator, the relativistic Hamiltonian splits into the sum of two complex conjugate spherical complex three-dimensional rotators. The corresponding excited "levels" also split into fine structure states, each level being naturally associated to a vector space irreducible under complex transformations isomorphic to the full Lorentz group. Every state is characterized by a set of quantum numbers with which typical families of rotator levels can be classified. (auth)

12025 ON THE NUCLEON-NUCLEON SCATTERING PHASE SHIFTS AND THE HIGH ENERGY NUCLEONS ELASTICALLY SCATTERED FROM LIGHT NUCLEI. Yoshiyuki Sakamoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 783-96(Oct. 1960). (In English)

The polarizations and triple scattering parameters of the nucleons elastically scattered from light nuclei are explained with the optical model potential by the use of the nucleon-nucleon scattering phase shifts. The set of the two-body scattering phase shifts meson-theoretically derived gives a small magnitude of the parameter of optical model potential V_{SR}. The small value of V_{SR} is caused mainly by the large positive $^3P_0$ state phase shift of the two-body scattering. The small value of V_{SR} gives a small polarization and a small absolute value of the triple scattering parameter for the nucleon scattered from the potential. The value of $(|V_S|/|V_C|)\,(\hbar/\mu c)^2$ calculated by the use of the meson-theoretical phase shifts is smaller than the ones based on the Gammel-Thaler and Signell-Marshak phase shifts. This difference is due mainly to the difference of $^3P_0$ state phase shifts in the two-body scattering. (auth)

12026 PHOTODISINTEGRATION OF THE DEUTERON IN MEDIUM ENERGY RANGE AND THE PION THEORETICAL NUCLEAR FORCES. Junji Iwadare and Masahiko Matsumoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 797-816(Oct. 1960). (In English)

The static pion potential, which consists of the central and tensor parts, was applied to the calculations of the photodisintegration of the deuteron in the medium energy range (20 to 80 Mev). The angular distributions were in good agreement with the observed results. The polarizations of final proton and neutron were also calculated. There are no observations yet to be compared with them. The general formulas are given for the angular distribution and polarization with the numerical coefficients for the lower multipole transitions. (auth)

12027 A QUANTITATIVE INVESTIGATION ON THE "COMPOSITENESS" OF A PARTICLE. Gaku Konisi and Kunio Yamamoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 24: 817-24(Oct. 1960). (In English)

A quantitative discussion is given concerning to what degree it is plausible to regard a particle as a composite one in the sense of the nonrelativistic quantum mechanics of particles (the "Compositeness"). For this purpose the probability that the system is in a state that cannot be regarded as a system of the constituent particles distributed with some probability densities was calculated. The main conclusion is that such a probability is proportional to the square root of the binding energy. (auth)

12028 P-WAVE PION-PION INTERACTION. Yoneji Miyamoto (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 24: 840-50(Oct. 1960). (In English)

A p-wave pion-pion resonance formula was derived by both the Chew-Mandelstam theory and the chain approximation. Adopting a scattering length $a = 1/5 \cdot (\hbar/\mu c)^3$, the resonance of 600 Mev and total width of 130 Mev, which is consistent with the results of Takeda et al., and Fulco and Frazer was predicted. The mean-square radius of isovector part of magnetic moment of a nucleon was calculated by using the chain approximation. (auth)

12029 ELASTIC ETHER THEORY OF ELEMENTARY PARTICLES. I. CLASSICAL THEORY. Hideo Fukutome (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 877-98 (Oct. 1960). (In English)

A unified model of elementary particles based on a renewed idea of "ether" is proposed. A general classical theory of the relativistic elastic continuum was developed. From the result of the general theory, a hypothetical relativistic elastic medium ether was introduced. It is an unusual elastic medium which has no mass and no energy in the undeformed state but has mass and energy in the deformed states which are due entirely to its elastic self-interaction. If the ether is elastically isotropic, then it has a conserving quantity called "the Lagrange spin" which has a property very similar to the iso-spin. It is not conserved if the elastic property of the ether is anisotropic. In this model the elementary particles are viewed as the excited states of the ether, and then strong, electromagnetic, and weak interactions are ascribed to the isotropic, cylindrically symmetric, and anisotropic elastic self-interaction of the ether, respectively. (auth)

12030 ON MASS FORMULA AND NEW IMAGE OF ELEMENTARY PARTICLES. Akira Ohmae (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 24: 910-12(Oct. 1960). (In English)

In a study of the total cross sections of high energy pion-proton scattering, the following rule was discovered among the magnitudes of each total energy in the center-of-mass system: $R_N\{1/4^2 - 1/(4 + m)^2\}$, m = 1, 2, 3, 4, ..., where R_N = 36 to 37 Bev and m = 2 corresponds to the 1st, m = 3 to the 2nd, m = 4 to the 3rd resonance levels, and m = 5 to 7 to the 4th with broad width. In a study of elementary particles possessing strangeness, the following series was found: $R_K\{1/8^2 - 1(8 + m)^2\}$, m = 1, 2, 3, ... A new concept for an image of elementary particles was conceived: that there exist plausible levels in ether or vacuum and the observed real particle is created or annihilated by a transition between them. (M.C.G.)

12031 ON THE NEW CONSTANT AND THE STRANGENESS. Akira Ohmae (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 24: 913-15(Oct. 1960). (In English)

A new constant R_N and a new quantum number obtained for elementary particles previously described were determined. The mass formula was also refined by means of the introduction of a correction corresponding to Rydberg's correction for the atom. A value of 38.29 Bev was obtained for R_N. The rest masses of elementary particles above muon mass and the total energies at resonances of total cross sections of π + p and K^- + p scatterings are given as $m = R\{1/(n + \frac{1}{2}s' + \delta')^2 - 1/(m + 1 + \frac{1}{2}s + \delta)^2\}$ where n, m,

l, s, s', δ, and δ' are quantum numbers and their corrections. (M.C.G.)

12032 MOVING EFFECT OF NUCLEON TO MESON FIELD. Tatsuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 917-18(Oct. 1960). (In English)

In order to examine the nonstatic effect in the determination of the meson-nucleon coupling constant, the moving effect of a nucleon to the meson field was studied. Results suggested that the nuclear force in the pseudo-scalar field contains not only the usual central and tensor potentials but also the potential derived from the gradient of the change in the coupling constant. An increase in nuclear potential of about 20% which became more significant with increasing energy indicated that the nonstatic effect is important. (M.C.G.)

12033 DISTRIBUTION OF PARTICLES IN A LOW DENSITY FERMION SYSTEM WITH ATTRACTIVE INTERACTIONS. Yasushi Wada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 24: 920-2(Oct. 1960). (In English)

In order to investigate the validity of the assumption that the configuration of the system of nuclear matter is not altered very much from that of degenerate Fermi gas, only those processes arising from the couplings of particle-particle and hole-hole pairs of the same total momentum were considered. Among the interaction Hamiltonian, those terms for the pairs of particles with a total momentum of zero were taken into account. Results indicated that, if the scattering length of a two-particle system is negative, the low-density system must have a particle distribution which is drastically changed from that of a degenerate Fermi gas. (M.C.G.)

12034 ON THE PIONIC AND ELECTROMAGNETIC STRUCTURE OF NUCLEONS. B. B. Dotsenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 295-307(May-June 1960). (In Ukrainian)

The structure of nucleons is discussed on the basis of the model conception of D. I. Blokhintsev-Yastrov. The ground states of the pionic shell of the nucleon are, according to the terminology of dispersion relations, the two- and three-pionic states. The two-pionic state was calculated fairly well, but a rigorous calculation of the three-pionic state is practically impossible at present. A simplified dynamic model is therefore proposed. According to this model, the emitted virtual pion is polarized in the field of the core into a pair, nucleon-antinucleon, acquires a nucleonic charge; and interacts with the core in conformity with Yukawa's law. The mass of the pion increases. By solving the appropriate Klein-Gordon equation, the wave functions and energy values of such a "bound" state are found. The motion of the core is taken into account by quasiclassical means (Sommerfeld's method). The distribution density of the core agrees with the distribution suggested by D. I. Blokhintsev and collaborators. The values of the mean square electric and magnetic radii and the contribution of the magnetic moment obtained from such a model agree with the experiment and with the theoretical estimations of other authors. (auth)

12035 ON THE DIFFRACTION SCATTERING OF PARTICLES WITH UNITY SPIN. V. K. Tartakovskii (Khar'kov State Univ.). Ukrain. Fiz. Zhur., 5: 445-9(July-Aug. 1960). (In Ukrainian)

Huygen's principle was formulated for monochromatic waves satisfying the Daffin-Kemmer equation. This equation was then applied to a consideration of elastic scattering and damping radiation of an ultrarelativistic particle with unity spin in an arbitrary field with central symmetry. (auth)

12036 ON THE WEIGHT OF A PHOTON. R. V. Paund. Uspekhi Fiz. Nauk, 72: 673-83(Dec. 1960). (In Russian)

Einstein proposed as a part of his theory of relativity the existence of an "equivalence principle" that predicted an increase in the energy of electromagnetic radiation when it fell under the influence of a gravitational potential. Experimental evidence is presented in support of this principle. The nuclear resonance absorption of γ quanta without recoil was utilized with Fe^{57} as the absorber of the 14.4-kev γ particle. A change in the frequency of the radiation of $\Delta\nu/\nu = gh/c^2$ under the influence of the gravitational field is expected according to theory, and experimental observations of this Doppler shift by Pound and Rebka found a change of 98 ± 4% of this quantity. A complete description is given of the experimental apparatus, the errors involved, the selection of source and absorber, and the theory involved. The increased mass and weight of coherent radiation is consistent with the predictions of the general theory of relativity. (TTT)

12037 CLASSIFICATION OF ELEMENTARY PARTICLES. D. Ivanenko and A. Startsev. Uspekhi Fiz. Nauk, 72: 765-98(Dec. 1960). (In Russian)

A review is presented of the recent history and current status of the problem of providing a unified description of the array of presently known elementary particles. The following concepts are treated: the theory of strangeness, as developed in 3-dimensional and 4-dimensional isotopic spin space; dynamic schemes of particle interactions, designed to "explain" the observed spectrum of particle masses and the models of global, fundamental, and general symmetry; anomalous spinors and bosons; the classification of particles in nonlinear spinor theory and the unified geometrical theories; the hypothesis of compound particles; and the problem of fitting leptons, characterized by weak interactions, into the over-all scheme. (TTT)

12038 PROCEEDINGS OF THE INTERNATIONAL CONGRESS ON MANY-PARTICLE PROBLEMS, UTRECHT, JUNE 13-18, 1960. N. G. Van Kampen, ed. Supplement to Physica, Volume 26, December 1960. Utrecht, Treasurer of the Physica Foundation. 217p.

Papers presented at the International Congress on Many-Particle Problems are given. Twenty-three of the papers are covered by separate abstracts. Two of the papers were previously abstracted for Nuclear Science Abstracts. (M.C.G.)

Neutron Physics

12039 (AE-47) AN EXPERIMENTAL STUDY OF THE SCATTERING OF SLOW NEUTRONS FROM H_2O AND D_2O. Karl-Erik Larsson, Sten Holmryd, and Kåre Otnes (Aktiebolaget Atomenergi, Stockholm). Dec. 1960. 44p.

The cold neutron technique was applied to the study of the scattering properties of light and heavy water. It is shown that with respect to neutron scattering, water behaves much like a solid. It is estimated that a water molecule occupies a stationary position for a period of $\sim 2 \cdot 10^{-12}$ sec, performing about 10 vibrations before it makes a diffusion jump of a length of at least 1.5 A. The consequences of the observations for neutron thermalization problems are discussed briefly. (auth)

12040 (ARF-1164-6) RESEARCH STUDY ON NEUTRON INTERACTIONS IN MATTER AS RELATED TO IMAGE FORMATION. Period Covered: July 1 to October 31, 1960. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 5, 1960. Contract AT(11-1)-578. 38p.

The effects of neutron scattering on the image quality are discussed, and the basis of a technique of "image synthesis" utilizing an optical analog to neutron scattering is described. This "image synthesis" technique will allow the relative importance to be assessed of detector characteristics on the fidelity of the neutron image formed and to obtain insight on the effect of neutron scattering on the image by simple optical bench experiments. The neutron-scattering point spread function, which is required for the image synthesis, was derived analytically for the single scatter case and the case of thick scatterers where the diffusion theory should be valid. A $\frac{1}{8}$-in.-diameter collimated neutron beam was set up, and data were obtained on the neutron beam after passing through various thicknesses of graphite as a scatterer. The indium foil activation (transferred to film) detection method was calibrated as a base to which other converter and detector sensitivities will be normalized. (auth)

12041 (BLG-52) CALCULATION OF A FAST NEUTRON CHOPPER SYSTEM. H. Ceulemans (Brussels. Centre d'Etude de l'Énergie Nucléaire). Oct. 8, 1960. 75p.

From the equations of motion of the neutron, the characteristics of neutron transmission through rotating slits are calculated. These characteristics include the form of the transmission probability curve, the width of this curve, and the maximum height. By the use of dimensionless coefficients in formulas and graphs, these factors can be used directly for any chopper design. Attention is also given to the influence of collimators and of beam divergency. The way in which they influence the transmitted spectrum is indicated. Limits for the chopper parameters are determined in order to satisfy the resolution requirements, and a choice is made according to the existing conditions at the reactor site. (auth)

12042 (CARDE-TM-294/59) MONTE CARLO CALCULATIONS ON NEUTRON DIFFUSION. A. Lemay (Canada. Armament Research and Development Establishment, Valcartier, Que.). Dec. 1959. 20p. (AD-243418)

The diffusion history of 2-Mev neutrons is followed in a bare reactor consisting of one atom of U^{235} for 300 molecules of water. A Monte Carlo program is used to compute the neutron history from birth until it escapes, produces fission, becomes thermal ($E < 0.03$ ev), or is captured. A total of 1500 histories is computed and the escape spectra, the spatial probability distribution of thermal neutrons, and the spatial distribution of fission events are plotted. (auth)

12043 (CEA-Bib-7) SPECTROMÉTRIE DES FLUX DE NEUTRONS INTERMÉDIAIRES ET RAPIDES. (Spectrometry of Intermediary and Fast Neutron Fluxes). J. Desdevises and D. Didier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 34p.

This reference list groups together a number of articles on the spectrometry of intermediary and fast neutron fluxes. It presents the methods used and describes the measuring apparatus and certain experiments which the latter has made possible. (185 abstracts). (auth)

12044 (NP-9687) EXACT SOLUTION OF THE SLOWING DOWN EQUATION. Report No. 158/IX. R. Bednarz (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). June 1960.

The slowing-down equation for the infinite homogeneous moderator is solved exactly. The solution is obtained in analytical form. The calculated collision density and escape probability are compared with the approximate Wigner formulas in the case of resonance no wider than one collision interval. (auth)

12045 (TID-6365) F2 TWO GROUP NEUTRON DIFFUSION PROGRAM ANP PROGRAM NO. 19. F. B. Smith (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 26, 1958. 70p. (DC-58-8-225)

A code is presented which solves the one-dimensional two-group diffusion equations $-(1/r^{\mu})\,(d/dr)\,r^{\mu}[D_1(d\phi_1/dr)] + (\Sigma_{a,1} + \Sigma_{s,1} + D_1K^2_{1,1})\,\phi_1 = S_1\,(\nu/k)\,(\Sigma_{f,1}\phi_1 + \Sigma_{f,2}\phi_2) + s1^{ext}$ and $-(1/r^{\mu})\,(d/dr)\,[r^{\mu}D_2(d\phi_2/dr)] + (\Sigma_{a,2} + D_2K^2_{1,2})\,\phi_2 = S_2\,(\nu/k)\,(\Sigma_{f,1}\,\phi_1 + \Sigma_{f,2}\,\phi_2) + \Sigma_{s,1}\,\phi_1 + S_2^{ext}$ as difference equations in multi-region plane, cylindrical, or spherical geometry subject to two-group albedo type boundary conditions at the outer boundaries. Fission density is improved with each iteration until the selected convergence criterion is met. Output consists of reactivity, k, after each iteration, and converged values of fission density and fluxes at each lattice point. An adjoint or a one-group calculation is also available. (auth)

12046 (USNRDL-TR-493) RESPONSE OF PHOTOGRAPHIC EMULSIONS TO THERMAL AND EPITHERMAL NEUTRONS. T. T. Mercer and R. Golden (Naval Radiological Defense Lab., San Francisco). Dec. 28, 1960. 22p.

The amount of activation by thermal and epithermal neutrons of silver in a photographic emulsion was calculated in terms of thermal neutron flux and cadmium ratio as determined by gold foils 1.27-cm diameter by 0.0297-cm thick. The dose-rate distributions around point sources of Ag^{108} and Ag^{110} were calculated and used to determine the dose to a photographic emulsion resulting from activation of its own silver by thermal and epithermal neutrons. It was found that the dose to an emulsion from thermal neutrons only could be expressed as $D(th) = 0.46 \times 10^{-10}(\overline{nvt})t_{Ag}$ rads, where $(\overline{nvt})$ is the average thermal neutron flux in neutrons/cm^2 and t_{Ag} is the silver content of the emulsion in mgm/cm^2. The ratio of the total dose to an emulsion from both thermal and epithermal neutrons to the dose caused by thermal neutrons only was obtained as a function of cadmium ratio. (auth)

12047 (UCRL-Trans-630(L)) ACTIVATION DISTURBANCES IN A NEUTRON FIELD BY INDIUM FOIL. H. Meister. Translated from Z. Naturforsch., 10a: 569-80(1955). 37p. (Includes original, 12p.).

The activation disturbances caused by circular indium foils in a thermal neutron field were measured in the scattering media, paraffin, and graphite by a comparison of the activation in the media with the activation in a sufficiently large hollow space. The measured disturbances follow the geometric dependency of the elementary diffusion theory, but they differ from it in absolute values. (auth)

12048 (UCRL-Trans-632(L)) DENSITY MEASUREMENT OF THERMAL NEUTRONS. E. Corinaldesi. Translated from Nuovo cimento, (9) 3: 131-41(1946). 23p. (Includes original, 11p.).

Density measurements of thermal neutrons are performed without considering the perturbation induced by the detector in the distribution of neutrons. Such an approximation is permitted as long as the detector is thin; for thick detectors the error can be considerable. Successively, considering that the formulas obtained thus cannot be applied to the case of finite-sized detectors without an appreciable error, calculations were performed for the perturbation of circular detectors of radius: R = 1/2, 1, 31/2, 21, where l is the diffusion length, assuming that the unperturbed density, q_T, is a constant. The ratio between Φ, the number of neutrons

absorbed by the detector per sec and q_T, is given as a function of the detector thickness for values of $\beta = R/l$, and compared with results obtained from formulas for plain infinite detectors. The ratio between the average value, $\bar{n}$, of the density beyond the detector and the unperturbed density, q_T, is given as a function of $\beta = R/l$, and compared to values for the infinite detector. (auth)

12049 (WAPD-TM-241) WANDA-5—A ONE-DIMENSIONAL NEUTRON DIFFUSION EQUATION PROGRAM FOR THE PHILCO-2000 COMPUTER. O. J. Marlowe and M. C. Suggs (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1960. Contract AT(11-1)-GEN-14. 36p.

The WANDA-5 program is an extension to the Philco-2000 computer of the WANDA series of programs which provide numerical solutions of the one-dimensional few-group neutron diffusion equations. From one to four lethargy groups are allowed with up to 500 mesh points distributed in 100 regions. (auth)

12050 AN ITERATIVE METHOD FOR NEUTRON TRANSPORT PROBLEMS WITH SPHERICAL SYMMETRY. W. R. Conkie (Atomic Energy of Canada Ltd., [Chalk River, Ont.]). Can. J. Phys., 39: 295-314(Feb. 1961). (AECL-1160)

An iterative method developed previously for transport problems with plane symmetry has been extended to problems with spherical symmetry. Particular application has been made to the problem of the neutron distribution for a black sphere embedded in a purely scattering medium with sources at infinity. The results compare favorably with those of other workers for this problem. (auth)

12051 THEORETICAL THERMAL NEUTRON FLUX SHAPE IN A SOLID CYLINDRICAL ROD. R. Bonalumi (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 8: 71-2(Jan. 1961). (In English)

A calculation is made by using the transport equation in a homogeneous infinite isotropically scattering medium with a plane isotropic uniform source, assuming a space-independent neutron spectrum. If a is the rod radius, the final result is $\varphi(r) = I_0(kr) + \lambda T(a,r)$. (T.R.H.)

12052 COLD NEUTRON BEAMS FROM SMALL LOW-TEMPERATURE MODERATORS IN REACTORS. F. J. Webb (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Sci. and Eng., 9: 120-6(Feb. 1961).

An investigation was made of the efficiency of several hydrogenous low-temperature moderators in the production of intense cold neutron beams from reactors. The dimensions of such a moderator are usually severely limited, but even small volumes of liquid hydrogen, liquid hydrogen deuteride, and solid methane were effective. A qualitative theoretical explanation is given of the degree of moderation observed. (auth)

12053 THERMAL NEUTRON ABSORPTION CROSS SECTIONS BY THE PULSED SOURCE METHOD. J. W. Meadows and J. F. Whalen (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 132-6(Feb. 1961).

The thermal neutron absorption cross sections of 21 naturally occurring elements and B^{10} were determined by comparing the time dependence of the neutron flux in water with the time dependence of the neutron flux in a water solution of the sample with the same geometric buckling. After making some small corrections arising largely from the change in the number of hydrogen atoms per cm^3 in the solution, the decay constant of the ratio curve gave the macroscopic absorption cross section averaged over the neutron flux spectrum. For a $1/v$ cross section, the 2200 m/sec cross section could be directly computed. For non-$1/v$ cross sections, the effective 2200 m/sec cross section was obtained. (auth)

12054 MEASUREMENTS OF NEUTRON SPECTRA IN WATER, POLYETHYLENE, AND ZIRCONIUM HYDRIDE. J. R. Beyster, J. L. Wood, W. M. Lopez, and R. B. Walton (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Nuclear Sci. and Eng., 9: 168-84(Feb. 1961). (GA-1514)

An experimental arrangement designed for accurate measurements of low-energy neutron spectra was assembled and tested. A pulsed high-current electron linear accelerator was used to produce short bursts of fast neutrons that were introduced into a moderating and absorbing assembly. The steady-state energy spectrum of neutrons in the assembly was determined by pulsed-beam time-of-flight techniques. Hydrogen-moderated systems poisoned with a number of common neutron absorbers (boron, cadmium, samarium) were studied, and the resulting spectra were compared with theoretical predictions using both free and bound hydrogen scattering kernels. In general, a marked difference existed between measured spectra and spectra calculated using a free hydrogen kernel. In the case of water where a detailed scattering kernel is available for room temperature, theory and experiment are in reasonable agreement. (auth)

12055 ON THE SOLUTION OF TRANSPORT PROBLEMS BY CONDITIONAL MONTE CARLO. D. W. Drawbaugh (Combustion Engineering, Inc., Windsor, Conn.). Nuclear Sci. and Eng., 9: 185-97(Feb. 1961).

The application of a conditional Monte Carlo method for estimating the solution of transport problems is described. Statistical estimators for solving transport problems by the conditional Monte Carlo method are given for both homogeneous and heterogeneous problems. The analog and conditional Monte Carlo solutions of a simple one-speed transport equation are compared with the exact deterministic solution. The application to deep penetration shielding problems is discussed. (auth)

12056 FLUX PERTURBATIONS BY THERMAL NEUTRON DETECTORS. G. Ronald Dalton and Richard K. Osborn (Univ. of Michigan, Ann Arbor). Nuclear Sci. and Eng., 9: 198-210(Feb. 1961).

The transport equation that describes the thermal neutron population in and around a neutron detector was converted to an iterative integral equation. This integral equation was then solved for a wide range of specific cases using a digital computer. Using this method of calculation, the effects upon neutron density of nonisotropic scatter in the surrounding medium, of finite detector dimensions, and of scatter by the detector were calculated to an accuracy of better than 1%. Detailed maps of the scalar neutron density in and around finite detectors were available from the calculations. The problem of nonisotropic, non-uniform initial neutron density was formulated using the integral method. (auth)

12057 AGE OF FISSION ENERGY NEUTRONS TO INDIUM RESONANCE IN WATER. R. C. Doerner, R. J. Armani, W. E. Zagotta, and F. H. Martens (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 221-40(Feb. 1961).

Previous calculations and measurements of the age of fission neutrons in water were tabulated with special emphasis on those aspects of the experiments which might require corrections or lead to errors. A plane-source geometry was assumed, and data taken in this geometry were interpreted in terms of these corrections. The measured

second moments of the distributions from 18, 24, and 30-in. sources were corrected for foil and source-plate mass effects. A geometric correction was then applied to obtain the age of fission neutrons in water as 27.86 ± 0.10 cm^2. (auth)

12058 FAILURE OF NEUTRON TRANSPORT APPROXIMATIONS IN SMALL CELLS IN CYLINDRICAL GEOMETRY. J. A. Thie (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 286-7(Feb. 1961).

In previous calculations of the thermal neutron flux fine structure in fuel-element cells, P_n and S_n approximations to the Boltzmann equation were used rather than diffusion theory P_1 approximations. It was found that in cylindrical geometry, approximations such as P_3, S_4, and S_8 can be poorer than P_1, especially for tightly packed lattices with a low-density coolant. Methods used to compute the fine structure in these cells having a constant source in the coolant are described. Results suggested that the anomalously large values of the disadvantage factor in higher-order approximations in cylindrical geometry may be a consequence of the boundary conditions at the cell boundary. (M.C.G.)

12059 INELASTIC MODERATION OF FAST MONOENERGETIC NEUTRONS. Clemens August Heusch (Technische Hochschule, Munich, Germany). Nukleonik 2: 228-40(Nov. 1960). (In German)

For the determination of inelastic collision parameters of fast neutrons on heavy nuclei, the almost monoenergetic neutrons produced in DD and DT reactions were passed through diffusers of heavy scattering material (lead or bismuth) in a spherical geometry. On introduction in the enclosed moderator volume, the neutrons possess a mean energy, which was determined by the quasi-linear dependence on their moving surface. Measurements on samples of various density leads, with the application of collision numbers from a Monte Carlo calculation, to the mean energy loss per inelastic collision. The data obtained can best be described by a linear dependence of the mean energy on the collision number. Their comparison with the evaporation theory of inelastic scattering shows complete agreement with respect to the dependence of the nuclear temperature on the energy of the incident neutron. The absolute value of the nuclear temperature is in agreement with the data obtained from theory and analogous experiments. (tr-auth)

Nuclear Properties and Reactions

12060 (AD-241846) THEORETICAL EVALUATION OF THE VARIANCE OF THE CORRELATION METHOD FOR THE TWOFOLD PROMPT RADIOACTIVE DECAY CHAIN WITH NON-CONSTANT SOURCE (thesis). Gary Thomas Smith (North Carolina State Coll., Raleigh). 1960. 55p.

The correlation function and the variance are developed for the twofold prompt, nonconstant source case. They are applicable to time correlation experiments in which the parent decays appreciably in a twofold parent-daughter cascade. Both are shown to duplicate the constant source case when the parent's decay constant is made sufficiently small. A quasi-numerical check is presented to verify the expression obtained for the variance. (auth)

12061 (AERE-R-3347) A CALCULATION OF THE ASYMMETRY DUE TO AN EXTENDED SECOND TARGET IN EXPERIMENTS TO DETERMINE NUCLEAR SPIN POLARIZATION. J. E. Evans (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1960. 9p.

A recalculation is presented of the nuclear reaction spin polarization equation $R/L = 1 + P_1P_2/1-P_1P_2$, where R/L is the ratio of intensities of the final reaction product measured to right and left of the target and P_1 and P_2 are the polarizations at the mean angles set by the apparatus. (J.R.D.)

12062 (BMI-1486) A SIMPLE EXPERIMENTAL METHOD FOR DETERMINING EFFECTIVE THRESHOLD ENERGIES AND CROSS SECTIONS. Richard G. Jung, Harold M. Epstein, and Joel W. Chastain, Jr. (Battelle Memorial Inst., Columbus, Ohio). Dec. 15, 1960. Contract W-7405-eng-92. 31p.

A facility was designed and fabricated to study fast-neutron activation techniques. With this facility, the neutron-energy spectrum from the BRR can be modified by means of liquids or solids surrounding the specimen at the irradiation position. The resonance and fast-neutron flux and energy spectra were measured as a function of distances through air, water, and monoisopropylbiphenyl (oil) with threshold detectors whose threshold energies are well known. Traverses were then made with foils whose reaction threshold energies and effective cross sections are not well established. By plotting the slope of the curves for corrected-saturation activity vs. distance against neutron energy for all reactions, the threshold energies of the unknown reactions were determined. Since the neutron spectrum had been accurately determined with known threshold detectors, the effective cross sections of the new detectors could be evaluated by dividing their saturated activity by the number of neutrons above their threshold energies. The results were as follows: $Ti^{47}(n,p)Sc^{47}$, E_{eff} = 2.40 Mev, σ_{eff} = 0.085 barn; $Ni^{58}(n,p)Co^{58}$, E_{eff} = 2.55 Mev, σ_{eff} = 0.226 barn; $Cl^{35}(n,\alpha)P^{32}$, E_{eff} = 4.10 Mev, σ_{eff} = 0.178 barn; $Fe^{54}(n,p)Mn^{54}$, E_{eff} = 5.10 Mev, σ_{eff} = 1.16 barn; $I^{127}(n,2n)I^{126}$, E_{eff} = 10.70 Mev, σ_{eff} = 1.28 barns; and $F^{19}(n,2n)F^{18}$, E_{eff} = 13.10 Mev, σ_{eff} = 0.121 barn. Some results of resonance-flux traverses through air and water are also included. (auth)

12063 (BRL-TN-1364) ANALYSIS OF THE GAMMA RADIATION EMITTED BY IRRADIATED COPPER. David U. Wright, Jr., Lowell H. Sohl, and Larry R. Cooper (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Aug. 1960. 20p.

Samples of spectroscopic grade copper were irradiated in the Graphite Reactor at Brookhaven National Laboratory for one month. The effects of the extended irradiation were observed in the form of γ spectra recorded at 11 and 26 months postirradiation. The recorded spectra are not those to be expected as a result of the irradiation of Cu^{63} and Cu^{65} alone, but for the most part are due to Ag^{110} and Co^{60}. (auth)

12064 (CISE-82) TECNICHE, APPARECCHIATURE E DATI SPERIMENTALI PER L'ANALISI CHIMICA E RADIOCHIMICA. 4. SPETTROMETRIA GAMMA: MISURE CON ANALIZZATORE A 200 CANALI E MONOCANALE A SCANSIONE AUTOMATICA. (Techniques, Procedures and Experimental Data for Chemical and Radiochemical Analysis. 4. Gamma Spectrometry: Measures by Analyzer with a 200-Channel and Monochannel Automatic Scanner). F. Cianflone and C. Triulzi (Centro Informazioni Studi Esperienze, Milan). Oct. 1960. 43p.

A series of gamma spectra obtained with various radioisotopes is presented. Each spectrum was studied to determine the best experimental conditions, the sensitivity of the instrument, and the reproducibility of the measurement. A magnetic-memory 200-channel pulse analyzer and an auto-

matic scanning monochannel analyzer were used for the pulse analysis. The isotopes studied were Au^{198}, Co^{57}, Ce^{141}, Hg^{203}, I^{131}, Ru^{103}, Sr^{85}, Cs^{137}, Ag^{110m}, Zr^{95}-Nb^{95} (in equilibrium), Mn^{54}, Zn^{65}, Na^{22}, Fe^{59}, and Co^{60}. (tr-auth)

12065 (GA-1362) RANGE OF RECOIL ATOMS. Status Report No. 2 for Period January 1, 1960 through March 31, 1960. V. A. J. van Lint and R. A. Schmitt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 15, 1960. 39p. Contract AF33(616)-6795.

A calibration experiment on the γ output of the linear accelerator was completed. An experiment was reported in which irradiation target foils were evaporated copper films of various thicknesses that were less than or comparable to the recoil atom range. Previous experiments on reflected atoms were repeated to place a smaller upper limit on the fraction of recoil atoms which are reflected from the catcher foil. Data are tabulated from experiments in which copper, gold, and silver target foils were used. Measurements on recoil-atom ranges from (γ,n) reactions in Zr, Mo, Rh, Ag, and Cd and measurements on recoil atoms from (γ,p) reactions in Gd, Pb, Mn, Co, Ag, and Th are reported. (For preceding period see GA-1193.) (J.R.D.)

12066 (GA-1690) INELASTIC SCATTERING OF NEUTRONS FROM VERY COLD MATERIALS. A. W. McReynolds and W. L. Whittemore (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 16, 1960. 26p.

For presentation at the International Atomic Energy Agency Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Vienna, October 11-14, 1960.

An electron linear-accelerator pulsed-neutron source was used for studies of the neutron scattering process at low temperatures, particularly for measurements where it was advantageous relative to a reactor source. Low temperature of the scattering medium is of interest from two viewpoints. Certain aspects of the lattice or liquid vibrational spectrum, particularly its low energy end, are best observed through thermal inelastic scattering of very cold neutrons by phonon emission. At such low neutron energies, however, the cross section for such processes becomes very low; whereas, the cross section for phonon absorption becomes much greater. The latter processes must be suppressed by maintaining low sample temperature. Measurements on hydrogenous and other moderating materials are reported. A second necessity for measurements at low incident energies is an adequately intense source of cold neutrons. Such sources were previously obtained by crystal filters transmitting only the weak low energy tail of the reactor thermal spectrum. A more satisfactory source in principle is a 4 to 20°K moderator in which the entire spectrum reaches thermal equilibrium kT ~ 0.0003 to 0.0016 ev. In practice such sources were not available because of difficulties of installing a cryogenic device in the high flux region of a reactor, where radiation heating requires rapid heat extraction. The decrease of energy loss cross section at low energies also necessitated a substantially larger moderating volume than was required at ~300°K. Cold moderator sources may be advantageously investigated by the electron linac, which with 3 to 5 μsec 25-Mev pulses on lead targets produces bursts of 5×10^{10} neutrons 120 times per second. The resultant source strength of $\sim 10^{16}$ neutrons per second during the pulse gave flux intensities comparable to bursts from a reactor and chopper. Advantages include the fact that the region immediately around the neutron source is readily accessible for normal cryostatic apparatus, and there is negligible radiation heating, activation, or hazard. A series of investigations was carried out to determine the behavior as cold neutron sources of a number of configurations of moderators, including H_2O, D_2O, CH_2, CD_2, and BeO at temperatures of 4, 80, and 300°K. Similar measurements with H_2 are in progress. (auth)

12067 (INSJ-34) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF THE (α,p) REACTION; I. C^{12}. I. Nonaka, H. Yamaguchi, T. Mikumo, I. Umeda, T. Tabata, and S. Hitaka (Tokyo Univ. Inst. for Nuclear Study). Dec. 9, 1960. 8p.

Numerical differential cross sections are tabulated for C^{12} (α,p) N^{15} reactions at E_α from 25.0 to 38.6 Mev at angles of 12.9 to 170.9°, using carbon foil targets and E_α = 34.6 Mev on soot targets at small angles and polystyrene film at other angles between 11.5 and 167.5°. (B.O.G)

12068 (INSJ-35) NUMERICAL DIFFERENTIAL CROSS SECTIONS OF THE (α,p) REACTION: II. B^{10}, N^{14}, O^{16}, AND Ne^{20}. H. Yamaguchi, I. Nonaka, T. Mikumo, S. Hitaka, I. Umeda, and T. Tabata (Tokyo Univ. Inst. for Nuclear Study). Dec. 9, 1960. 11p.

Differential cross sections are tabulated for the (α,p) reactions of B^{10}, N^{14}, O^{16}, and Ne^{20}. The energies of the incident α particles ranged from 26.7 to 33.1 Mev. (J.R.D.)

12069 (JINR-P-491) K VOPROSY O MODULYATSII "BIENNYAKH" V KVANTOVYKH PEREKHODAKH. (On the Question of Modulation and "Beats" in Quantum Transitions). M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 22p.

Transitions that occur simultaneously between neighboring energy levels give rise to a beat phenomena. This phenomenon was considered theoretically, and the probability amplitude for photon production was calculated first for two levels and then generalized for several levels. Beats in space as well as in time were included in the most general expressions. These beats were closely allied with the modulation of harmonic vibrations, and the modulation for the electromagnetic field was derived. A knowledge of the character of split levels and the distance between neighboring levels predicted frequencies $<10^9$ cycles/sec. The use of gamma-gamma coincidences from the resonance in cooled crystals (the Mössbauer effect) will permit such beat phenomena to be experimentally observed. (TTT)

12070 (JINR-P-493) TSEPOCHKA RASPADA $Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$. (Decay Scheme of $Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$). A. A. Abdurazakov, K. Ya. Gromov, B. Dalkhsuren, B. S. Dzhelepov, I. Yu. Levenberg, et al. NOVYE IZOTOPY Ir^{184} I Pt^{187}. (New Isotopes Ir^{184} and Pt^{187}). V. I. Baranov, K. Ya. Gromov, B. S. Dzhelepov, Zyong-chong Baĭ, T. V. Malysheva, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 22p.

I. The existence of Yb^{164} with $T_{1/2}$ = 75 ± 2 min, producing a daughter Tm^{164} with $T_{1/2}$ = 2 ± 0.5 min, was found among tantalum spallation products. Tm^{164} transforms into stable Er^{164}, emitting positrons with a maximum energy of 2940 ± 20 kev and gamma rays of 91.5 ± 0.1 and 211 ± 2 kev. II. A decay scheme is suggested for Ir^{184}, with a half life of 3.1 ± 0.3 hr. A new isotope (Pt^{187}) with a half life of 2.0 ± 0.4 hr was also found. (R.V.J.)

12071 (KAPL-M-JRS-13) STANDARD MUFT CROSS-SECTION LIBRARY. J. R. Stehn (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 25, 1960. Contract W-31-109-Eng-52. 86p.

The MUFT code computes neutron slowing-down distributions and group average cross sections for homogeneous mixtures of whatever elements there are cross sections for in the MUFT library. The cross sections are given for each of the 54 lethargy ranges chosen as the group struc-

ture. The 32 elements and isotopes for which cross sections are available are given, each with the identifying number used on the tape. (W.L.H.)

12072 (LA-2424) CHARGED PARTICLE CROSS SECTIONS—NEON TO CHROMIUM. Darryl B. Smith, comp. and ed. (Los Alamos Scientific Lab., N. Mex.). Jan. 31, 1961. Contract W-7405-eng-36. 137p.

Plots of cross sections for charged particle reactions are presented for Ne^{20} through Cr^{53}. A bibliography is included. (J.R.D.)

12073 (LMSD-326020) FAST NEUTRON CROSS SECTIONS OF OXYGEN AND NITROGEN. Preliminary Report. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). July 6, 1960. 46p. Contract AF29(601)-1765.

Measurements of fast neutron cross sections of oxygen and nitrogen, performed using a 3.5-Mev Van de Graaff accelerator, are reported. The measurements include total, elastic, and nonelastic cross sections for neutrons at five energies from 4.99 to 8.0 Mev and the yields and angular distributions of neutrons from the $C^{13}(d,n)N^{14}$ and $Be^{9}(\alpha,n)C^{12}$ reactions. (W.L.H.)

12074 (NP-9497) MEASUREMENTS WITH (p,γ) REACTIONS. (thesis). Karel Jan van Oostrum (Delft, Netherlands. Technische Hogeschool). 1959. 87p.

The importance of proton-capture γ rays in nuclear research is pointed out, and experimental apparatus and experiments are described to show the usefulness of (p,γ) reactions in studying level schemes and checking apparatus. The proton beam of the Delft Van de Graaff generator was used. The γ scintillation counters, associated electronic equipment, angular distribution arrangement, determination of crystal efficiency, and proton energy calibration are described. Measurements were made on the reaction $Si^{28}(p,\gamma)$ and resonances were observed at 0.370, 1.64, and 2.09 Mev. The decay scheme for each level was determined. Angular distribution measurements at 0.370 Mev yield unambiguous spins of $\frac{5}{2}$ for the resonance level and $\frac{3}{2}$ for the first excited state in P^{29}. Experimental data for the P^{29} excited levels were compared with minor-nucleus Si^{29} levels. (T.R.H.)

12075 (NP-9701) POSITRON RADIATION OF Tm^{166}. Report No. 177/I-A. S. Chojnacki, Yu. Norseev, Z. Preibisz, J. Wołowski, and J. Zylicz (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Oct. 1960. 15p.

The Tm^{166} positron spectrum was examined with a long-lens β spectrometer fitted with helical baffles for separating the electrons from the positrons. Two components were found of maximum energy (1920 ± 20 and 1219 ± 40 kev) and relative intensities (1 : (0.092 ± 0.018)). The total number of positrons for a decay amounts to about 1%. The decay scheme of Tm^{166} and the applicability of the theory of nonaxial nuclei are discussed. (auth)

12076 (NP-9856) NUCLEAR REARRANGEMENT AND SIMPLE NUCLEAR REACTIONS. Paul Benioff (Weizmann Inst. of Science, Rehovoth, Israel). 1960. 21p.

The effect of nuclear rearrangement on p,pn and p,2p reaction cross sections is considered. It is found possible to give an exact definition of the rearrangement effect only in the case of independent particle models. In general, it seems reasonable to require that the rearrangement effect be contained in the overlap of the wave functions of the target and product nuclear states. It is shown that this overlap appears directly in the expression for the p,pn and p,2p reaction cross sections. The rearrangement effect is explicitly calculated for two independent particle models and is shown to cause a fractional change of 1/A in the reaction cross sections. (auth)

12077 (ORNL-3042) RESONANCE SCATTERING OF LINEARLY POLARIZED GAMMA RAYS ON NUCLEI. G. Felsner and M. E. Rose (Oak Ridge National Lab., Tenn.). Feb. 24, 1961. 15p. Contract W-7405-eng-26.

The resonance scattering of linearly polarized γ rays on nuclei is calculated with angular correlation methods. Hyperfine splitting is assumed. The result is discussed for the Mössbauer nuclei Fe^{57} and Ni^{61} with a simple geometry (the magnetic field and the directions of the absorbed and the reemitted quantum are mutually perpendicular). The geometry optimizes the coherent contribution to the resonance scattering. The dependence of the scattering probability on an external magnetic field implies under favorable circumstances a measurement of the magnetic moment of the excited state and of the internal field at the nucleus. (auth)

12078 (TID-11715) LOW ENERGY CONVERSION ELECTRONS OF Ag^{106} AND Rh^{106}; Pd^{106} LEVELS. W. G. Smith (Purdue Univ., Lafayette, Ind.). [1960?]. 24p.

The low-energy (<0.935 Mev) conversion electrons emitted in the decays of Ag^{106} and Rh^{106} were observed in electron spectrographs. Twenty-nine transitions were observed in Ag^{106} decay; 2 transitions were observed in Rh^{106} decay. The data were used to postulate the following levels in Pd^{106}: 0-(0+); 0.5116-(2+); 1.1272-(2+); 1.1331-(0+); 1.2287-(4+); 1.5568-(3,4+); 1.7020-(2+); 1.9310-(3,4+); 2.0825-(3+); 2.3040-(3,4+); 2.3489-(3,4+); 2.3636- or 1.9469-(3,4,5+); 2.7336-(5,6+); 2.7540-(5+); and 2.9494-Mev (5,6+). The proposed level scheme indicates that ~5%, ~85%, and ~10% of the electron capture of Ag^{106} proceeds to the 2.9494-, 2.7540-, and 2.7336-Mev levels, respectively. (auth)

12079 (TID-11752) ADIABATIC DEMAGNETIZATION IN A ROTATING REFERENCE SYSTEM. C. P. Slichter and William C. Holton (Illinois. Univ., Urbana). 1960. 43p.

Redfield proposed that under some circumstances a magnetic resonance should be described by saying the spin system achieved a temperature in a reference system that rotated at the frequency of the applied alternating field. This proposal was based on experiments in which characteristic times of observation were long compared to the spin-lattice relaxation time. A theory of spin-lattice processes was necessary to analyze the results. A set of experiments to verify this hypothesis, using times short compared to the spin-lattice relaxation and which test his hypothesis without the need for a theory of spin-lattice relaxation, is described. The experiments are shown to be similar to conventional adiabatic demagnetization, performed, however, in a rotating reference frame. Redfield's ideas are thereby presented in a particularly simple form. The differences between reversible and irreversible losses in magnetization are illustrated, and it is shown, for example, that one can invert the magnetization with respect to the static field by passing through the resonance using alternating fields much less than the line-width. The studies were made using the sodium resonance in NaCl. (auth)

12080 (UCRL-9372) THE CROSS SECTIONS FOR THE FORMATION OF ASTATINE ISOTOPES MADE BY THE BOMBARDMENT OF Bi^{209} WITH He^{3} (thesis). E. Thomas Strom (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1960. Contract W-7405-eng-48. 31p.

Bismuth-209 was bombarded with He^3 on the Berkeley heavy-ion linear accelerator. Cross sections for the formation of astatine isotopes were measured. The experimental

cross sections were compared with theoretical cross sections, calculated using the Jackson model. The results of this work are compared with those of other workers, and proposals for further research are made. (auth)

12081 SCATTERING OF SLOW NEUTRONS IN FERRIMAGNETIC CRYSTALS. Jerzy Kociński (Inst. of Physics, Academy of Science, Poznań, Poland). Acta Phys. Polon., 19: 691-9(1960). (In English)

Cross sections for scattering of slow neutrons by spin waves in ferromagnetic crystals were calculated. The type of ferromagnetics with spins pointing in the same direction while at absolute zero temperature was treated. The formula for the scattering cross section given by Halpern and Johnson for the ferromagnetic case was generalized to lattices with two kinds of spins. By means of it, the cross sections for various scattering processes were calculated in the manner used by Maleev in the ferromagnetic case. (auth)

12082 NEUTRONS FROM THE CAPTURE OF A POLARIZED MU MESON. Elihu Lubkin (Columbia Univ., New York). Ann. Phys. (N.Y.)., 11: 414-82(Dec. 1960).

The angular distribution of neutrons from the capture by a spinless nucleus of a totally polarized μ meson in the 1s Bohr orbit is calculated via two single-particle nuclear models, termed "modified Fermi gas" and "square well." A direct 4-fermion coupling with a left-handed neutrino represents the weak interaction. The major results depend on the Fermi, Gamow-Teller, and pseudoscalar coupling constants: c_F, c_G, c_P. The angular distribution is $1 + \kappa(C_-/C_+)\cos\Theta$, where Θ is the angle from the muon spin to the neutron momentum, $C_\pm = |c_F|^2 \pm 2\,|c_G|^2 + |c_G - (p/2M)c_P|^2$, p is the neutrino energy, M is the rest energy of a nucleon, and κ is the calculated asymmetry reduction factor. The "modified Fermi gas" calculations, performed for Ca^{40} and Pb^{208}, employ a Fermi sea of protons and $\mu^- + p \rightarrow \nu + n$ to produce neutrons at a localized zone of the nucleus, which are followed through the nuclear surface via geometrical optics. Those neutrons which escape at this stage of the calculation are termed "direct neutrons," and a κ restricted to direct neutrons is ~0.7. Because of total internal reflection and attenuation, most neutrons do not escape directly. Captured neutrons are assumed to excite boil-off, which is isotropic, and which strongly dominates the lower $\frac{2}{3}$ of the neutron energy spectrum. The top quarter of the spectrum is relatively free from boil-off. The "square-well" calculations, performed for O^{16}, Si^{28}, and Ca^{40}, employ eigenfunctions of a real square well of finite depth for the nucleons, and a spherical harmonic expansion up to g-waves, inclusive, of the neutrino plane wave. κ ranges from several to ~30%. In such a single-particle model upper shells are found to dominate strongly captures with productions of free neutrons. The case of rarefied hydrogen is treated. (auth)

12083 EFFECTIVE SPIN-ORBIT POTENTIAL IN CORRELATED HEAVY NUCLEI. John W. Clark (Washington Univ., St. Louis, Mo.). Ann. Phys. (N. Y.)., 11: 483-500 (Dec. 1960).

A many-body system is considered in which a particle N moves under the influence of the remaining N−1 particles, taken to be nucleons, and every total particle-particle interaction contains a repulsive core. An expression is derived for that part of the effective one-body potential felt by particle N which is caused by a specific portion v_{iN} of its interaction with each of the nucleons $i = 1, \cdots, N-1$, on the basis of a system wave function of the Jastrow type, neglecting exchange contributions involving particle N. This result is used to estimate the spin-orbit splittings in the region of Pb^{208} generated by the Gammel-Thaler and Signell-Zinn-Marshak two-body spin-orbit potentials. In both cases the theoretical splittings are of the correct sign and about the right magnitude to explain the observed doublet separations. (auth)

12084 LEPTON CONSERVATION AND DOUBLE BETA-DECAY. Eugene Greuling and R. C. Whitten (Duke Univ., Durham, N. C.). Ann. Phys. (N.Y.)., 11: 510-33(Dec. 1960).

Double β decay was investigated without assuming lepton conservation. If the lepton part of the universal V−A current operator is linear in the massless Majorana neutrino field, leptons are conserved. The intermediate state neutrino is completely polarized and may not be reabsorbed to produce a neutrinoless double β decay final state. Two slight modifications of the interaction, (1) finite neutrino mass, and/or (2) a deviation from exact equality of the effective V and A lepton currents, result in the creation of an incompletely polarized intermediate state neutrino which may then be reabsorbed. Neutrinoless double β decay, in violation of lepton conservation, is then possible. These neutrinoless modes of double β decay are computed for several nuclei and are compared with the usual lepton conserving two-neutrino mode. Measurable competition between these decay modes may exist. The abandonment of lepton conservation does not alter significantly any of the predictions of the universal V−A Fermi interaction for all first-order β processes. (auth)

12085 SPIN DEPENDENCE OF HIGH ENERGY PROTON SCATTERING. T. T. Thwaites (Univ. of Rochester, N. Y.). Ann. Phys. (N.Y.), 12: 56-67(Jan. 1961).

The elastic scattering of 200-Mev polarized protons by N^{14} was measured in the forward maximum of the cross section and compared to the scattering produced by C^{12} under the same conditions. No conclusive evidence for a nuclear spin dependence of the scattering was found. (auth)

12086 THE ANGULAR DISTRIBUTIONS OF NEUTRONS SCATTERED FROM VARIOUS NUCLEI. R. O. Lane, A. S. Langsdorf, Jr., J. E. Monahan, and A. J. Elwyn (Argonne National Lab., Ill.). Ann. Phys. (N.Y.), 12: 135-71(Feb. 1961).

The angular distributions of neutrons scattered from Li^6(96%), Li(normal), Be, C, Si, Ca, Cu, Sn, Pb, and U^{238} were measured for incident energies in the range from 50 to 2300 kev. In these measurements the energy spread of the incident neutron beam was sufficiently large to average out most of the pronounced fluctuations due to individual scattering resonances. In addition, a series of angular distributions of neutrons scattered at resonances were measured for the zero-spin nuclei C^{12}, O^{16}, Si, and S^{32}, as well as for the isotopes Li^6 and Li^7. The results are presented in terms of the least-square values of the coefficients in a Legendre-polynomial expansion of the differential scattering cross section relative to the laboratory system of coordinates. The various corrections that were made in order that these data represent a microscopic cross section are discussed. (auth)

12087 PAIRING FORCES AND NUCLEAR COLLECTIVE MOTION. A. K. Kerman (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N.Y.), 12: 300-29(Feb. 1961).

The influence of pairing forces on the collective vibrations in nuclei is studied using a perturbation expansion. The result is found to agree with that given by Belyaev using the superconductivity approximation except that the number of particles is conserved. A general discussion is given of the collective quadrupole energy surface. In particular, the anharmonic terms in the expansion about zero

deformation and the general character of the stability of axially symmetric deformed systems are discussed. (auth)

12088 THE FISSION CROSS-SECTIONS OF ^{232}Th, ^{235}U, ^{237}Np, AND ^{238}U FOR NEUTRONS OF ENERGIES RANGING FROM 10 to 22 MeV. V. M. Pankratov, N. A. Vlasov, and B. V. Rybakov. Atomnaya Energ. 9: 399-401(Nov. 1960). (In Russian)

The time-of-flight analysis and D(d,n)He^3 neutron source were utilized in determination of the neutron fission cross sections of Th^{232}, U^{235}, Np^{237}, and U^{238} at 10 to 22 Mev. The time-of-flight method was used for separating the mono-energy neutron effects in the reaction. The deuteron energy was varied from 6.5 to 19.5 Mev (neutron energy 9.7 to 21.7 Mev, respectively) by means of interchangeable foils placed in front of the target. The energy straggling determined by the thickness of the deuterium gas target was 250 kev at E_d = 19.5 Mev and 700 kev at E_d = 6.5 Mev. All measurements were taken at 0° angle to the deuteron beam. The statistical error of measurements does not exceed 3%. The distribution of U^{235} fission cross sections is sharply nonmonotonic due to the (n,3n) reaction threshold of about 1.5 Mev which exceeds the tertiary fission. The fission cross section of U^{235} at 10 to 22 Mev is smaller than anticipated. (R.V.J.)

12089 MEASUREMENT OF RADIATIVE-CAPTURE CROSS-SECTIONS FOR FAST NEUTRONS ^{51}V, ^{93}Nb, ^{186}W, AND ^{205}Tl. Yu. Ya. Stavisskiĭ and V. A. Tolstikov. Atomnaya Energ. 9: 401-3(Nov. 1960). (In Russian)

Measurements of neutron cross sections were carried out by the relative activation method at an energy range of E_n = 0.03 to 2.1 Mev. The reaction T(p,n)He^3 from the Van de Graaff accelerator was used as the neutron source. The activation at E_n < 300 kev was made at 95° to the proton beam and at E_n > 300 kev at 0°. The distribution of 200-kev neutrons was ±12 to 20 kev and for neutrons with higher energies up to ±30 to 40 kev. The energy distribution was determined by the errors in U^{235} fission cross sections (~25% at E_n < 60 kev, ~12% at E_n = 60 to 150 kev, and ~8% at E_n > 150 kev). Cross sections of radiative capture of fast neutrons by V^{51}, Nb^{93}, W^{186}, and Tl^{205} are plotted. (R.V.J.)

12090 GAMMA RAY PRODUCTION IN INELASTIC SCATTERING OF 3 Mev NEUTRONS. A. L. Androsenko, D. L. Broder, and A. I. Lashuk. Atomnaya Energ. 9: 403-6(Nov. 1960). (In Russian)

Gamma rays produced in inelastic scattering of 3-Mev neutrons on B, C, F, Na, Mg, Al, Si, P, S, Fe, Co, Ni, Cu, Zn, Se, Zr, Nb, Mo, Cd, Sn, Sb, La, Ta, Pt, Au, and Pb were studied. The data obtained are tabulated, and the pulse spectra of γ rays in inelastic scattering of 3-Mev neutrons on platinum, gold, and lanthanum are plotted. (R.V.J.)

12091 ON THE POLARIZATION OF NEUTRONS FROM MUON CAPTURE BY THE NUCLEUS. W. Majewski (Inst. of Physics, Polish Academy of Sciences, [Warsaw]). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 8: 467-70(1960). (In English)

The polarization of neutrons emitted from the nucleus as a result of unpolarized μ meson capture has been calculated. It was found that, if the weak interaction is V-A, then the fastest neutrons from the capture are almost totally polarized in a direction opposite to their momenta. In the present study the same problem is examined, taking into account the virtual pion corrections, namely, the effective PS interaction and the interaction with derivatives of the lepton field. From a comparison with the previous study, it is concluded that, in the framework of the universal Fermi interaction theory, measurement of the longitudinal polarization of neutrons from muon capture in nuclei apparently cannot clarify the question of the virtual pion effects in this process. (J.S.R.)

12092 EXCITED STATES OF O^{18} STUDIED BY THE REACTION $H^3(O^{16}_{4+},p\gamma)O^{18}$. A. E. Litherland, R. Batchelor, A. J. Ferguson, and H. E. Gove (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 39: 276-94(Feb. 1961). (AECL-1157)

Gamma rays from the excited states of O^{18} at 3.63 and 3.92 Mev were observed using the reaction $H^3(O^{16}_{4+},p\gamma)O^{18}$ at an incident O^{16} energy of 14 Mev. Both states were observed to emit γ rays to the 1.98-Mev 2+ first excited state of O^{18}. No evidence for crossover transitions was found, and in each case the crossover transition was estimated to be ≤15% of the cascade transition. Angular correlations of the γ rays were obtained and these strongly support an assignment of spin 0 to the 3.63-Mev state and a spin of 2 for the 3.92-Mev state. These assignments were confirmed by a recent experiment on the $O^{16}(H^3,p)O^{18}$ reaction which gives the assignments 0+ and 2+ for these two states. Thus the states at 3.55, 3.63, and 3.92 Mev form a triplet with assignments 4+, 0+, and 2+, which strongly resembles the vibrational spectra found in heavier nuclei. However, the measured angular correlations of the γ rays from the 3.92-Mev state show only a small admixture of electric quadrupole in the 1.94-Mev γ ray with relative amplitude +0.1 ± 0.1. A lower limit of ~10^{-12} sec on the lifetime of the 3.63-Mev state was obtained from the absence of a Doppler shift of the 1.65-Mev cascade γ ray. (auth)

12093 ON THE PRODUCTION OF Be^7, Mg^{28}, AND Ni^{66} IN THE SLOW NEUTRON FISSION OF U^{235}. J. C. Roy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys. 39: 315-25(Feb. 1961). (AECL-1164)

The yields of 53-day Be^7, 21.3-hr Mg^{28}, and 56.6-hr Ni^{66} from the slow neutron fission of U^{235} were investigated. Upper limits of 3×10^{-7} and 4.2×10^{-8}% were set for the fission yields of Be^7 and Mg^{28}, respectively. A fission yield of $2.0 \pm 1.0 \times 10^{-8}$% was found for the formation of Ni^{66}. These results are compared with the current knowledge of the frequency of triple fission of U^{235}. (auth)

12094 CROSS SECTION FOR THE FORMATION OF PROTACTINIUM-227 BY SPALLATION OF THORIUM WITH 155-MEV PROTONS. Georges Bouissières, Michel Hussonnois, Marc Lefort, Yvette Legoux, Gabriel Simonoff, and Xavier Tarrago. Compt. rend., 251: 2155-6(Nov. 14, 1960). (In French)

The cross section for the formation of Pa^{227} by the reaction Th^{232}(p,6n) at 155 Mev was determined by two different methods. The value obtained, 1.5 ± 0.2 mb, is compared with the results obtained by other authors. (tr-auth)

12095 SPECTRA OF α PARTICLES PRODUCED BY THE REACTION OF DEUTERONS ON BORON-10 AND THE EXCITED STATES OF BERYLLIUM-8 BETWEEN 0 AND 8 MEV. Roland Bilwes, Claude Gérardin, and Denise Magnac-Valette. Compt. rend., 251: 2157-9(Nov. 14, 1960). (In French)

The study of the α particle spectrum from the reaction B^{10}(d,α)Be^8 with a magnetic spectrometer of the Buechner type shows no excited state in Be^8 other than that at 2.9 Mev between 0 and 8 Mev. (tr-auth)

12096 THE INTERPRETATION OF THE ENERGY LEVEL SCHEME OF CADMIUM-112. Christian Ythier. Compt. rend., 251: 2915-17(Dec. 19, 1960). (In French)

The energy levels of Cd^{112} can be decomposed into four families of vibrational levels corresponding to the ground

level and to the three O^+ levels at 1.23, 1.41, and 1.84 Mev. The energy levels established and the interpretation given these levels are sketched. It is shown that the observed distances in each series are equal between corresponding successive levels. (J.S.R.)

12097 ON THE ENERGETIC SPECTRUM OF HEAVY NUCLEI EXCITED BY SLOW NEUTRONS. Yu. V. Tsekhmistrenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. R.S.R., No. 10, 1388-92(1960). (In Ukrainian)

Two models of the nucleus are considered: the generalized model of O. Bohr with maximally strong coupling and the oscillatory model with oscillatory interaction between the particles, which can be reduced to a system of noninteracting quasi-particles. In the first case, a probability approach with two random parameters established the repulsion effect for levels of states with the same symmetry, i.e., the density of probability for the distribution of the distances between levels with small ΔE is shown to be proportional to ΔE. The corresponding density of probability for levels of states with different symmetry when $\Delta E \to 0$ does not become zero. This result may be easily extended to the case of any number of parameters. For the second model, strict proof is given to show that a considerable region of the energy spectrum is of an equidistant nature, the levels being degenerate only in projections of the angular moment. (auth)

12098 ABSOLUTE MEASUREMENT OF THE RESONANCE ENERGY OF THE REACTION $Ni^{58}(p,\gamma)Cu^{59}$ AT 1.84 MEV. H. H. Staub and H. Winkler (Physik-Institut der Universität, Zurich, Switzerland). Helv. Phys. Acta, 33, 526-8 (1960). (In German)

The resonance energy of the $Ni^{58}(p,\gamma)Cu^{59}$ reaction at 1.84 Mev was measured with a 180° absolute magnetic spectrometer. The experimental arrangements are described in detail. The three measurements agreed within ±100 ev of each other for an absolute value of 1842.9 ± 0.45. (J.S.R.)

12099 α-γ ANGULAR CORRELATION MEASUREMENTS ON THE Be^8 NUCLEUS. V. Meyer, H. H. Müller, H. H. Staub, and R. Zurmühle (Physik-Institut der Universität, Zurich, Switzerland). Helv. Phys. Acta, 33: 528-9 (1960). (In German)

A highly excited Be^8 nucleus results from the capture of a proton by Li^7. The excited Be^8 decays directly to the ground state or to the 2.9-Mev level by emission of γ. The nucleus can then decay into two α particles. It is assumed that these two types of radiation occur concurrently. Since the γ-α angular correlation is strongly dependent on the mixing ratio, the γ-α correlation is suitable for the determination of the mixing. The mixing ratio of the electric quadrupole radiation to the magnetic dipole radiation is 0.017 ± 0.006 at the angles 90, 135, and 180°. (J.S.R.)

12100 ANOMALIES IN THE NUCLEAR EVAPORATION OF COPPER. E. Jeannet, Cl. Bovet, J. Rossel, and E. Vaucher (Univ., Neuchâtel, Switzerland). Helv. Phys. Acta, 33: 529-34(1960). (In French)

Copper foils of 15μ thickness were irradiated with 500-Mev neutrons, and the charged particles emitted during the reaction were detected with Ilford L-4 emulsions. The particles emitted were classified according to their charge as "protons" (Z = 1) and as "alphas" (Z = 2). The energy was measured from the path, and the ϑ angle was determined with respect to the incident flux. The excess of low-energy particles is not represented by the usual approximation $V' = V(R + \chi)$. The hypothesis of deformation oscillations of the nucleus is not sufficient to explain the deviation observed. A calculation based on reasonable estimations of the length Γ_d shows, in effect, that for the α the quantum barrier transparence leads to a mean life for the nucleus of the order of 10^{-16} sec, too low to be compatible with an evaporation model that would incorporate the tunnel effect. The excess of α particles at high energies is connected with a strong anisotropy of these particles. The number of these abnormal α (25%), is too large with respect to the number of abnormal protons (less than 5%) to permit the hypothesis of the preexistence of α particles in the nucleus. (J.S.R.)

12101 PRELIMINARY RESULTS ON INTERACTIONS OF PS PROTONS IN NUCLEAR EMULSIONS. G. Cvijanovich (Physikalisches Institut der Universität, Bern, Switzerland), B. Dayton, P. Egli, B. Klaiber, W. Koch, M. Nikolić, R. Schneeberger, H. Winzeler, J. C. Combe, W. M. Gibson, W. O. Lock, M. Schneeberger, and G. Vanderhaeghe. Helv. Phys. Acta, 33: 546-50(1960). (In German)

Tracks of PS protons (mean energy of 21 Bev) in nuclear emulsions were followed, and 491 reactions with nuclei were found. A mean free path of 37.8 ± 2.7 cm for the star products was determined. The frequency distribution of the stars as a function of the number of the grey and black tracks emitted was compared with the frequency distribution obtained at 6.2 Bev. The comparison indicated that the number of evaporation tracks is practically independent of the primary energy between 6 and 24 Bev. Of all interactions 12.4% appear as so-called white stars, which are stars with only rare secondary tracks. The frequency distribution of white stars was determined as a function of the number of their charged secondary tracks. The angular distribution of the secondary track in the L system was measured against the primary direction. (J.S.R.)

12102 INELASTIC SCATTERING OF 14-MEV NEUTRONS ON HEAVY NUCLEI. P. Huber, P. Niklaus, and R. Wagner (Physikalische Anstalt der Universität, Basel, Switzerland). Helv. Phys. Acta, 33: 560-4(1960). (In German)

The validity of the statistical model in the description of the inelastic scattering of 14-Mev neutrons on heavy nuclei was tested experimentally. The discrepancies with respect to the dependence of the nuclear temperature on the nucleon number of the scattering material were of special interest. The spectrum of neutrons inelastically scattered on Bi^{209} was used to determine the correction factor for the nuclear temperature. A natural mixture of lead was then used as scattering medium, and the experimental distribution of the neutrons agreed well with the predictions of the statistical model. The nuclear temperature of the nonmagic mercury isotopes was determined to be 0.8 Mev. The temperatures of these three nuclei behave almost inversely to that predicted by the statistical model. It is suggested that magic numbers affect the temperature. (J.S.R.)

12103 MEASUREMENT OF THE NEUTRON DIFFERENTIAL SCATTERING CROSS SECTION ON OXYGEN-16 IN THE MEV RANGE. P. Huber and W. Hunzinger (Physikalische Anstalt der Universität, Basel, Switzerland). Helv. Phys. Acta, 33: 570-6(1960). (In German)

The experimental conditions used in the measurement of the neutron differential scattering cross section on O^{16} are described. The scattering process takes place in an aluminum ionization chamber filled with O_2 at 2 atm. In order to eliminate the space effect, the ionization chamber is provided with an iron collimator. Deuterons of 1 Mev are projected onto a heavy ice target after magnetic collimation. The ionizations produced by recoil are measured ballistically with a linear amplifier. Neutrons from sources

other than the ice target perturb the measurements. Therefore, from all measured spectra, the perturbation originating from other sources and from the target carrier is subtracted. Graphs of measurements made at 2.95 and 3.40 Mev are given as examples. (J.S.R.)

12104 n'-γ CORRELATIONS OF INELASTIC NEUTRON SCATTERING. I. EXPERIMENTS ON Mg^{24}. H. R. Brugger, T. Niewodniczanski, and M. P. Steiger (Laboratorium für Kernphysik ETH, Zurich, Switzerland). Helv. Phys. Acta, 33: 576-83(1960). (In German)

The $Mg^{24}(n,n'\gamma)$ reaction with 3.45-Mev neutrons was studied to determine the n'-γ angular correlation. The correlation was measured by the intensity in a ring geometry. The experimental apparatus and the evaluation of the results are described in some detail. It is shown that the measurements agree, essentially, with Satchler's statistical model for the angles 15, 25, and 45°. (J.S.R.)

12105 n'-γ CORRELATIONS OF INELASTIC NEUTRON SCATTERING. II. CALCULATIONS. S. Prêtre, H. R. Brugger, and M. P. Steiger (Laboratorium für Kernphysik ETH, Zurich, Switzerland). Helv. Phys. Acta, 33: 583-90 (1960). (In German)

The calculations of the neutron-gamma correlation function by the statistical method have shown that $W(\theta_{n'}, \theta_{\gamma})$ depends very little on the form of the basic optical potential. Therefore, the variation with respect to a correlation function is prominent in the excitation direction. These facts increase the importance of correlation experiments as it is very difficult to adapt theoretical correlation surfaces to the measured values by variation of the parameters of an optical model when experimentally both intermediate nucleus excitation and direct excitation are present. (tr-auth)

12106 MEASUREMENT OF THE GAMMA CONSTANT OF RADIUM. K. K. Aglintsev, G. P. Ostromukhova, and E. A. Khol'nova. Izmeritel'naya Tekh., No. 12, 40-2(Dec. 1960). (In Russian)

The γ constant of radium is $\Gamma\ (Ra) = P \times 3600/Af$, where P is the dose strength at 1 cm in r/sec (Roentgens/second), A is the activity in mc (millicuries), and f is a correction coefficient that takes absorption into account. Measurements were carried out on samples of radon in equilibrium with its short-lived decay products in order to exclude the effect of self-absorption due to the presence of radium. Measurements of the dose strength P were made on a standardized counter with a free air space. Corrections were applied for absorption in air at various pressures. The activity of the radon samples was measured on a γ colorimeter and on an α colorimeter The activity values obtained by the two methods agreed within 1%. The average value of the γ constant of radium was found to be 8.97 ± 0.18 r/hr-mc-cm. The value is 8.1 r/hr-mc-cm with a 0.5-mm-thick platinum cover. (TTT)

12107 ELASTIC SCATTERING OF PROTONS ON NUCLEI. F. R. Arutyunyan. (Inst. of Physics, Academy of Sciences, Armenian S.S.R.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 5, 77-90(1959). (In Russian)

Scattering of 66- to 195-Mev protons in 4 to 7 mm lead layers and 40- to 72-Mev protons in 2 to 5 mm copper layers was investigated. The differential angular distributions of scattered protons were plotted. Curves are given for multiple Coulomb scattering for point and expanded nuclei. At large scattering angles ($\varphi > 5.4$), where Coulomb scattering is negligible, all the scattering events are considered purely nuclear. At an angle larger than $\varphi = 5.4$, the point nucleus number for protons scattered by 7-mm lead layers (substracting multiple Coulomb scattering) is 9, corresponding to a cross section $\sigma_{\varphi > 5.4} = (0.032 \pm 0.011)\ \sigma_{geom.}$. The integral cross section for diffraction scattering at scattering angles larger than $\varphi = 5.4$ equals $\sigma = 0.0340_{\sigma\ geom.}$ in good agreement with experimental data. (R.V.J.)

12108 PRESENT CONCEPTS OF β DECAY. V. A. Lyubimov. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1021-34(Sept. 1960). (In Russian)

An analysis is made of the experimental and theoretical results which explain weak interactions and β decay. The longitudinal electron polarization, the two-component electron in β decay, the two-component neutrino, and the universal theory of Fermi interactions are discussed, as well as symmetry transformations and temporary parity. In addition, a review is given of the basic conclusions of the β decay theory postulating that in allowed transitions the β spectrum, is Fermion in shape; electrons have total polarization, equal to v/c; the neutrino consists of two-components (A and V variations); the vector constant cannot be renormalized; and temporary parity is conserved. The deviations from the established theory, the weak Gell-Mann magnetism, and deviation of β spectra from Fermi shape and from electron polarization are analyzed as examples of exceptions supporting the basic theory. Two concepts describing weak interactions, Fermion interactions through intermittent vector boson and direct interaction of four Fermions, are mentioned. 54 references. (R.V.J.)

12109 INVESTIGATION OF U^{234} AND U^{235} α EMISSION FINE STRUCTURE. S. A. Baranov, A. G. Zelenkov, and V. M. Kulakov. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1035-40(Sept. 1960). (In Russian)

A double-focusing large magnetic spectrometer with strong light and relatively high resolving power was used in the investigation of U^{234} and U^{235} α spectrum fine structure. The calibration was carried out with three monoenergetic α-particle groups with variable energy: 6110 kev(Cm^{242}), 5495 kev(Pu^{238}), and 4768 kev(U^{234}). The calibration proved suitable for the work carried out at 4150 to 4800 kev. The α-particle group of U^{234} corresponding to the ground state of Th^{230} (E_{α} = 4768 kev) was used as standard. Among the three known transitions to the rotational levels of Th^{230} (0^+, 2^+, and 4^+) the level 4^+ was for the first time observed with a spectrometer. The experiments observed 13 groups of α particles. Analysis of the data confirms the postulate that the U^{235} α spectrum fine structure corresponds to the transitions on the four and five singlet states of Th^{231}. The smallest forbiddeness coefficients are exhibited by the group α_{13}, α_8, and α_{10}. Considering that the spin of U^{231} in the ground state is $^5/_2$ with a negative parity, the above groups on the Th^{231} level will exhibit the same quantum characteristics. A scheme of energy levels for Th^{231} is suggested; however, the plotted decay scheme should be considered only as probable. Some additional data on conversion electron spectra should be helpful in plotting a more accurate scheme. (R.V.J.)

12110 MAGNETIC FIELD EFFECT ON THE RESONANCE ABSORPTION OF γ RAYS. V. A. Lyubimov and A. I. Alikhanov, (Inst. of Theoretical and Experimental Physics, the Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1076-8(Sept. 1960). (In Russian)

The influence of a magnetic field on the resonance emission and absorption without recoil was studied utilizing the Zeeman effect in the γ transition of Sn^{119*} with energy 23.8

kev and lifetime 2.67×10^{-8} sec (the Sn^{119*} γ ray emission is 23.8 kev and x ray 25 kev). A krypton and propane-filled proportional counter was used for recording the γ-ray pulses of 20 to 30 kev. A strong drop (15%) in soft radiation intensity was observed with the cooling of the source down to 100°K. Measurements were also made of the effect of filter thickness on the reduced intensity at 100°K. With cooled source and absorber the intensity of the soft emission rises with the increase of the magnetic field. The magnetic field, by splitting the 23.8-kev level, shifts the emission energy without recoil from resonance energy with an order of magnitude of 10^{-7} ev while the shift of the 23.8-kev level in a weaker magnetic field is considerably smaller. This results in reduced absorption in the absorber and an increase in intensities. (R.V.J.)

12111 NEW Ir^{184} AND Pt^{187} ISOTOPES. V. I. Baranov, K. Ya. Gromov, B. S. Dzhelepov, Zyong Chong Bai, T. V. Malysheva, V. A. Morozov, B. A. Khotin, and V. G. Chumin. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, the Academy of Sciences. U.S.S.R. and Joint Inst. for Nuclear Research, Dubna). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1079-82(Sept. 1960). (In Russian)

A Danish type β spectrometer was used for studying conversion electron spectra of the iridium fraction formed by a deep spallation reaction in gold. A new Ir^{184} isotope with half life 3.1 ± 0.3 hr was discovered, and a decay scheme is suggested. A new isotope Pt^{187} with half life of 2.0 ± 0.4 hr was also found. (R.V.J.)

12112 ON THE EXISTENCE OF Te^{119} ISOMERS. N. G. Zaĭtseva, M. Ya. Kuznetsova, I. Yu. Levenberg, V. N. Pokrovskiĭ, and V. A. Khalkin. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1083-5(Sept. 1960). (In Russian)

The decay of Te^{119} isomers and relative yields of the reaction were studied. The Te^{119} isomers were prepared together with other tellurium isotopes by bombarding KI plates with 250-Mev protons. The tellurium and iodine were separated 15 min following the irradiation. Two radiochemically pure preparations of Te(I) and T(II) formed. Only short-life Te^{119} (12 ± 1 hr) was present in the preparation of Te(II). The β and γ spectra of Te(I) and Te(II) were found, and the short-life isomer of Te^{119} with 660-kev γ line intensity and weak positron emission of ~ 550 kev was observed. The ratios $\gamma/\beta^+ > 5$, $\beta^+/e^- \approx 5$. The half life period of Te^{119} was 14 ± 2 hr, the γ lines (most noticeable E_γ = 150 and 1200 kev) corresponding to a half life of 5 days were observed in Te(I) while for Te(II) it is T = 12 ± 1 hr. A decay sheme is given for A = 119. The developed data permitted simple determination of the relative production cross sections of I^{119}, Te^{119}, and Te^{119*} by the accumulation of Sb^{119} in Te(I) and Te(II) and by the γ(660)-kev intensity in the preparation. The ratio of relative cross sections is $\sigma_{Te^{119}} : \sigma_{I^{119}} : \sigma_{Te^{119*}} = 1 : 1.5 : 3$. The relative cross sections determined by various methods are in good agreement within the order of accuracy of ± 10%. (R.V.J.)

12113 STUDIES OF U^{235} α DECAY WITH IONIZATION α SPECTROMETER. A. A. Vorob'ev, A. P. Komar, and V. A. Korolev. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1092-8(Sept. 1960). (In Russian)

An ionization α spectrometer working in coincidence with a γ spectrometer was used in studies of the α decay of U^{235}. The α spectrum was studied without γ coincidences and with various γ coincidences with α particle groups. The measurements were made with the source enriched with U^{235}; however, the more intense line of U^{234} (98%) was used for stabilizing the amplification coefficient and as a standard in measuring the energy of the U^{235} α particles. The number of coincidences was ~4 pulses/min^{-1}, using a two-dimension multi-channel analyzer (γ spectrum was measured with 50 channel analyzer and α spectrum with 28 channel analyzer). The α spectrum without γ coincidences and with γ coincidences with various channels of the α analyzer was plotted, and multipolar γ transitions were determined. A variation of the U^{235} α decay scheme, based on the measurements of the α and γ spectra, is included. (R.V.J.)

12114 THE DECAY SCHEME OF Eu^{147}. Yu. A. Aleksandrov, Yu. A. Nemilov, M. K. Nikitin, and Sh. Piskorzh. (Leningrad State Univ., U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1099-1104(Sept. 1960). (In Russian)

A two-channel scintillation spectrometer with fast-slow coincidence scheme (resolving power 5×10^{-8} sec) was used in the investigations of γ-γ coincidence and angular anisotropy of cascade γ transition for Eu^{147}. The europium fraction chromatographically separated from the tantalum target was kept for 30 days in order to reduce the activities of Eu^{146} and Eu^{145}(T = 5 days); the presence of Eu^{148} and Eu^{149}(T = 50 days) strongly interfered with the experiments. Cascades of γ transitions, 76–200–600, 120–676, and 200–600 kev, were discovered, and x-ray coincidences (with an energy of ~40 kev) with weak γ rays were also measured. Spectra of Eu^{147} γ-ray coincidences with 40-kev x rays, the γ-rays spectra of Eu^{147} (weak region), and strong-region coincidences with 76- and 120-kev γ rays are plotted, and a decay scheme for Eu^{147} is plotted on the basis of the obtained data. (R.V.J.)

12115 THE DECAY SCHEME OF $Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$. B. Dalkhsuren, I. Yu. Levenberg, A. N. Murin, Yu. V. Norseev, V. P. Pokrovskiĭ, and I. A. Yutlandov. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1105-8(Sept. 1960). (In Russian)

Experiments were undertaken to verify the existence of daughter activity (A = 164) for ytterbium (75 min) and to determine the half life of Tm^{164}. The chromatographic method and fast ytterbium and thulium separation methods did not produce good results. An attempt was made to accumulate the Tm^{164} in ytterbium by taking a drop of ytterbium from the front of the ytterbium and thulium chromatogram and examining the intensity variations of 510-kev γ rays (the peak of annihilation emission) with the time. The 510-kev line was selected because the positron emission belongs to Tm^{164} (the difference of Tm^{164} and Eu^{164} mass is 3785 and 3097 kev). The results of the initial region of 510-kev γ ray accumulation are plotted. The half life period of Tm^{164} was found to be 2 ± 0.5 min, and the existence of $Yb \xrightarrow[75\ min]{K} Tm \xrightarrow[2\ min]{K,\beta^+} Er$ was confirmed. The postulated decay scheme for the chain A = 164 ($Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$) is presented. (R.V.J.)

12116 NEW NEUTRON-DEFICIENT PLATINUM ISOTOPES. T. V. Malysheva, B. A. Khotin, A. K. Lavrukhina, L. N. Kryukova, and V. V. Murav'eva (Vernadskiĭ Inst. of Geochemistry and Analytical Chemistry and Lomonosov Moscow State Univ., U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1109-12(Sept. 1960). (In Russian)

Conversion electron spectra and genetic bonds were studied for neutron-deficient platinum isotopes produced by 660-Mev proton spallation of gold. High specific activity platinum and iridium were separated from irradiated metallic gold. The separation of platinum and iridium was accomplished by the chloride complex anion exchange. The curve of Ir(III) wash-out with 8N HCl is shown. The data on platinum fraction conversion electron spectra are tabulated. The half-life periods of platinum isotopes were

found by separating the daughter iridium from the platinum fraction at equal time intervals from 1 to 4 hr. The half life for Pt^{186} and Pt^{187} with activity of Ir^{186} (T = 15 hr) and Ir^{187} (T = 13 hr) was 2.2 ± 0.5 hr, which is in good agreement with published data. The half life of platinum determined with the activity of daughter iridium (T = 3 hr) was 2.6 ± 0.6 hr. According to the previously reported data the new isotope Pt^{184} has a half life of 2.6 ± 0.6 hr. (R.V.J.)

12117 NEUTRON-DEFICIENT CERIUM ISOTOPES. (PRODUCTS OF EUROPIUM SPALLATION BY 660-MEV PROTONS). A. K. Lavrukhina, G. M. Kolesov, and Tien Hsiao-ên. (Vernadskiĭ Inst. of Geochemistry and Analytical Chemistry, the Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1113-18(Sept. 1960). (In Russian)

Cross sections of rare-earth isotope production in europium fission by 660-Mev protons were studied. The maximum yields of neutron-deficient isotopes are Ce^{134}, Pr^{137}, Nd^{139}, Pm^{141}, Sm^{142}, and Eu^{144}. Characteristics of the identified light-isotope distribution enable prediction of other unknown light isotopes. The data confirm the efficiency of neutron-deficient cerium isotope production by 660-Mev proton bombardment of europium. The isotopic composition of rare-earth elements in the earth's crust is different from the europium fission products (which are much lighter). In the earth's crust the ratio of Ce^{136} and Ce^{138} is 0.8 and in europium fission it is 0.4. Experiments were made to verify the production of Pr^{134} (half life of 1 hr) in samarium spallation by 660-Mev protons. The γ spectrum of cerium daughter product after separation of Pr fraction was measured with a γ spectrometer and γ lines of 0.128 (T ≈ 4 to 5 hr), 0.216 (T ≈ 17 hr), and 0.440 Mev were observed. (R.V.J.)

12118 NEUTRON-DEFICIENT OSMIUM ISOTOPES. Yu. A. Surkov, G. M. Chernov, A. K. Lavrukhina, and Z. V. Khromchenko. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1119-23(Sept. 1960). (In Russian)

Neutron-deficient osmium isotopes produced by 660-Mev proton bombardment of gold were studied with a 100-channel scintillation γ spectrometer and β and γ counters. The analysis of the energy distribution and decay curves for γ lines and total β and γ activity identified isotopes of Os^{182} (T ~20 hr, E_γ = 510 kev,), Os^{183} (T ~13 hr, E_γ = 168, 382, and 1110 kev), Os^{183*} (T ~10 hr, E_γ = 171 and 846 kev), and Os^{185} (T ~90 days, E_γ = 646 kev) is given. Measurements with front-window counter showed half lives of T_1 ~23 min, T_2 ≈ 3 hr, T_3 ~20 hr, (Os^{182}, Os^{183}), and T_4 ~90 days (Os^{185}). The presence of Os^{183} and Os^{183*} γ lines in $Os_{(daughter)}$ indicates the existence of unidentified Ir^{183} isotope which, during decay, transforms into Os^{183} ground and isomer states. The radioactivity accumulated in the Os fraction and separated from irradiated gold was analyzed in order to determine the mass number of the new Os isotope with half life of 2.7 hr. The mother nucleus Re^{181} has half life of 3 hr, and the mass number assigned to the new osmium isotope is 181. The data indicate also the existence of Ir^{183} (with half life of several hours), which produces the Os^{183} and Os^{183*} isomers with T ~13 and 10 hr. The mass number of 23-min osmium (E_γ = 170 kev) was not determined. There is a possibility that it is an isomer of one of the identified osmium isotopes. (R.V.J.)

12119 ANGULAR β-γ CORRELATION IN La^{140} AND Ce^{141} DECAY. V. P. Rudakov. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1124-5(Sept. 1960). (In Russian)

Measurements were made of the angular β-γ correlations in La^{140} decay (half life of 40 hr). The threshold of the β spectra is 2.2 Mev and of the γ spectra is 1.6 Mev; the threshold energy of the weaker partial spectrum is 1.7 Mev. The La^{140} was prepared by neutron irradiation in a reactor. The measured coefficient of anisotropy α = 0.12 ± 0.04, which does not contradict the previous value of the anisotropy coefficient for β-γ transition was $4^- \xrightarrow{\beta} 2^+ \xrightarrow{\gamma} 0^+$; the obtained coefficient for the 1.8-Mev β particle is 0.22. Experimental and theoretical data are correlated by measuring the Ce^{141} decay. The half life of Ce^{141} is 32.5 days. Nearly 75% of all decay events correspond to the excited level transitions to 145-kev Pr^{141}. The threshold energy of the β spectrum is 430 kev. The β-γ transition takes place between $\frac{7}{2}^- \xrightarrow{\beta} \frac{7}{2}^+ \xrightarrow{\gamma} \frac{5}{2}^+$. Measurements were made of 400-kev β particles. The γ spectrometer recorded γ quanta with maximum energy of nearly 150 kev. The obtained coefficient of anisotropy was α = 0.006 ± 0.020. (R.V.J.)

12120 ELECTRON CONVERSION SPECTRA OF DYSPROSIUM FRACTION. A. A. Abdurazakov, K. Ya. Gromov, B. S. Dzhelepov, and G. Ya. Umarov (Middle-Asia Polytechnic Inst. and Joint Inst. for Nuclear Research, Dubna, U.S.S.R.) Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1126-34(Sept. 1960). (In Russian)

Electron conversion spectra of dysprosium isotopes in deep tantalum spallation (E_p = 600 Mev) were studied with a constant magnetic field β spectrometer. The results of experiments with dysprosium fraction spectra at 25 to 1000 kev conformed the published data on conversion electrons: Dy^{157}(T = 8.2 hr), Dy^{155}(T = 10 hr), Tb^{155}(T = 5.6 hr), and Tb^{153}(T = 62 hr). A new level of 662.0 kev is suggested in Dy^{155} decay; the K capture branch is confirmed for Dy^{153} decay. The γ transition magnitudes hv = 86.6, 82.3, 99.6, 244.5, 244.5, and 147.8 kev are confirmed, and new γ lines of 17.48, 218.9, 240.7, 274.4, 303.8, 389.8, and 415.7 kev were discovered. The presence of Dy^{152} in the dysprosium fraction produced by tantalum bombardment by fast neutrons was established, and the new γ transition line of 257.2 kev was found in Dy^{152} decay. The γ quanta energies hv = 411.3, 271.3, 432.5, 588.4, and 616.2 kev appearing in Tb^{152} decay were confirmed and a new 186.9-kev γ transition was found. (R.V.J.)

12121 DECAY OF Nd^{140} AND Pr^{140}. E. I. Biryukov, O. I. Grigor'ev, B. S. Kuznetsov, and N. S. Shimanskaya. Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1135-44 (Sept. 1960). (In Russian)

A gamma spectrometer with proportional counter was used for measuring the soft x ray L and K emission from the equilibrium mixture of Nd^{140} and Pr^{140}, prepared by 660-Mev proton bombardment of a tantalum target. (R.V.J.)

12122 ENERGY DISTRIBUTION OF Be^8 IN C^{12} THREE α PARTICLE DECAY UNDER THE ACTION OF PROTONS AND NEUTRONS. S. S. Vasil'ev, V. V. Komarov, and A. M. Popova. (Inst. of Research in Nuclear Physics, Moscow State Univ., U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1149-52(Sept. 1960). (In Russian)

The mechanism of $C^{12} \rightarrow 3\alpha$ decay under the action of 8.5- and 19-Mev neutrons and 15- to 30-Mev protons was studied. The probability of the intermediate Be^8 nucleus in the $C^{12} \rightarrow B^8 + \alpha \rightarrow 3\alpha$ cascade and resonance interaction of two α particles in the finite state is analyzed, as well as the existence of the wide Be^8 level with center at 11.7 Mev and levels distributed between 3 and 11 Mev. The reactions $C^{12}(n,n3\alpha)$ in three-prong and $C^{12}(p,p'3\alpha)$ in five-prong stars in photoemulsion, irradiated by variable energy neutrons and protons, were observed. The energy distributions of α particles in the center-of-mass system of C^{13} in $C^{12}(n,n'3\alpha)$ reaction were plotted for one group of

incident neutron energies and for four groups of α particles in the center-of-mass of N^{13} in $C^{12}(p,p', 3\alpha)$ reaction. In spite of the variations of incident nucleon energy from 14 to 30 Mev, the maximum of the α-particle energy distributions remains at ~ 3 Mev. Energy distributions for the B^8 in $C^{12}(n,n', 3\alpha)$ at E_n = 14 to 19 Mev and $C^{12}(p,p', 3\alpha)$ at E_p = 15 to 30 Mev are calculated with assumption of simultaneous decay. The obtained data indicate the probability of C^{12} decay into three α particles with a strong resonance interaction of finite state particles. (R.V.J.)

12123 ENERGY DISTRIBUTION OF PRODUCTS IN NUCLEAR REACTIONS EMITTING SEVERAL PARTICLES. V. V. Komarov and A. M. Popova (Inst. of Scientific Research in Nuclear Physics, Moscow State Univ., U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1153-6 (Sept. 1960). (In Russian)

The energy distributions of products in reactions emitting three particles were determined by a method which considers the interactions between particles with relatively small pulses (which can be accurately determined); the interaction parameters are available from the particle scattering experiments. The interactions between a particle pair with small relative pulse and other particles are analyzed in Born approximation. The method is used for determining the energy distribution of He^3 nuclei in d + T → He^3 + n + n reaction at 25 and 27° in the center-of-mass system of ~ 12-Mev impinging deuterons. The potential scattering of two single-state neutrons was considered, and the constant of neutron-neutron interaction was equal to 70 kev. The method was also used for evaluating the energy distribution of neutrons in the reaction p + d → p + p + n at 0 to 180° angle in the center-of-mass system in relation to the direction of the incident proton at a total reaction energy of ~ 4 Mev. The method may be useful in the spectral analysis of reaction products from d + d, d + T, d + α, T + T, and other similar reactions in order to determine the role of interactions of products and the existence of excited states in light nuclei. (R.V.J.)

12124 THE HALF-LIFE OF ANTIMONY-125. E. H. Klehr and A. F. Voigt (Ames Lab., Ames, Iowa). J. Inorg. & Nuclear Chem., 16: 8–9(Nov. 1960). (In English) (IS-109)

The half life of Sb^{125} separated from uranium fission products was determined to be 2.6 ± 0.1 years by measurements on a Lauritsen electroscope over a 5-year period. (auth)

12125 NEW NEUTRON DEFICIENT ISOTOPES OF KRYPTON. F. D. S. Butement and G. G. J. Boswell (Liverpool Univ.). J. Inorg. & Nuclear Chem., 16: 10–15(Nov. 1960). (In English)

Two new activities were found in the neutron-deficient isotopes of krypton produced by [p,xn] reactions on bromine. The half lives were determined to be 12.0 ± 1.0 min and 5.5 ± 0.4 min. The activities are assigned to Kr^{74} and Kr^{75}, respectively, on the basis of their genetic relationships with bromine isotopes. The isotope Br^{74} was observed to emit a positron with a maximum energy of 4.7 Mev, and the half life of this isotope is 25.7 ± 0.9 min. (auth)

12126 DETERMINATION BY MASS SPECTROMETRY OF PRODUCTION CROSS SECTIONS OF HEAVY FRAGMENTS BY 155-MEV PROTONS ON O^{16}. E. Gradsztajn (Faculté des Sciences, Orsay, France). J. phys. radium, 21: 761-4(Nov. 1960). (In French)

The isotope dilution method applied to the determination of the known cross section of the reaction $V^{51}(n,\gamma)V^{52}$ gave satisfactory results. It was then used for studying the formation of Li^6 in O^{16}. The target, bombarded with 155 Mev protons, is tridistilled water. Simultaneously the production cross section of Be^7 under the same conditions was measured by counting the 480-kev γ rays. The ratio of these two cross sections is in agreement with recent calculations made by I. Dostrovsky et al. (auth)

12127 UNIFIED MODEL FOR THE PHENOMENA OF NUCLEAR PHOTODISINTEGRATION NEAR 20 MEV. Georges Monsonego (Faculté des Sciences, Orsay, France). J. Phys. radium, 21: 765-70(Nov. 1960). (In French)

A unified model for the study of the giant resonance is formulated which takes into account the individual and collective character of this phenomenon. Two unitary transformations are performed on the Hamiltonian of the nucleus, introducing two new conjugate operators α and π, with a subsidiary condition on the eigenfunctions since the number of degrees of freedom is increased. In the new Hamiltonian, there are: a collective part in terms of α and π, an intrinsic part, and interaction terms. This treatment based on the success of the Bohr and Mottelson phenomenological model seems to be successful. The theoretical calculations of the energy, width, and cross section of the giant resonance agree with the experimental data. The subsidiary condition plays an important role in the calculation of the width. The effect of neutron-proton exchange forces and the angular distribution of the emitted particles are also considered. (auth)

12128 SCATTERING OF SLOW NEUTRONS BY LIQUID HYDROGEN. G. Sarma (Centre d'Études Nucléaires, Saclay, France). J. phys. radium, 21: 783-8(Nov. 1960). (In French)

The differential slow neutron scattering cross section by liquid hydrogen is expressed, under some reasonable assumptions, as a product of two factors of simple physical meaning. The first factor, throughout spin correlations, involves transitions between molecular states and finally leads to a kind of an angular dependent scattering length, which is computed exactly for every transition in the rigid rotator approximation. A second factor depending only on the translational motion of the molecules remained, which turns out to be a Fourier transform of the well-known pair correlation function for a monatomic liquid. It is shown that what might be called the "coherent" part of the scattering, i.e., the part involving correlation between pairs of distinct molecules, is negligible. Therefore the scattering is mainly related to the so-called self-correlation function. Recoil appears naturally as a prominent feature. It is shown that the scattering is generally well described by means of a perfect gas model, taking into account the recoil of the molecules. This model leads to well-separated peaks at a given angle. The small-angle elastic scattering, where the perfect gas model is no longer valid, should allow for the measurement of a coefficient of self diffusion. (auth)

12129 MEASUREMENTS OF BETA-GAMMA CORRELATION. CIRCULAR POLARIZATION IN Au^{198} AND Sb^{122}. K. P. Deutsch and P. Lipnik (Université, Louvain, Belgium). J. phys. radium, 21: 806-7(Nov. 1960). (In French)

In preliminary measurements on β-γ correlation, the magnetic field of the scatterer effects the coincidence circuit. Results obtained by eliminating this systematic error are reported. The polarization found in Sb^{122} is related to that measured for Au^{198}. The results for Sb^{122} with respect to gold are $\underline{e}\%$ = −0.02 ± 0.12, $\underline{v}/\underline{c}$ = 0.89 ± 0.25, (1 − P) = 0.97 ± 0.05, cos $\underline{\theta}$ = 0.960 ± 0.005, K = 4.50 ± 0.50, and A_1 = −0.03 ± 0.034. (J.S.R.)

12130 CALORIMETRIC MEASUREMENT OF THE PERIOD OF Au^{198}. J. Robert (Laboratoire Curie, Paris). J. phys. radium, 21: 808(Nov. 1960). (In French)

The radioactive period of Au^{198} was measured with an automatically compensated adiabatic microcalorimeter. The value obtained from the analysis of the experimental points was T = 64.79 ± 0.09 hr. (J.S.R.)

12131 EXCITATION FUNCTION FOR THE REACTION $O^{16}(\alpha,pn)F^{18}$. Michiaki Furukawa and Shigeo Tanaka (Tokyo Univ.). J. Phys. Soc. Japan, 16: 129(Jan. 1961). (In English)

The energy dependence of cross sections for the reaction $O^{16}(\alpha,pn)F^{18}$ was determined for alpha-particle energies from 21 to 40 Mev. The results are plotted as an excitation function. The observed production of F^{18} below the threshold energy (23.2 Mev) for the (α,pn) reaction is attributed in part to the (α,d) reaction with a threshold energy of 20.4 Mev. The half life of F^{18} was determined to be the same as the literature value (112 min). (D.L.C.)

12132 SHORT-LIVED ACTIVITY OF Ag^{106}. Mitsuo Sakai, Hidetsugu Ikegami, and Toshimitsu Yamazaki (Tokyo Univ.). J. Phys. Soc. Japan, 16: 148-52(Feb. 1961). (In English)

Twenty-four-min Ag^{106} was produced by the (n,2n) reaction. New gamma rays of 295, 450, 625, 883, 1045, 1190, 1398, 1525, 1730, 1880, and 2170 kev were observed with a scintillation gamma-ray spectrometer. These gamma rays were compared with those appearing in the decay of Rh^{106}, Rh^{106m}, and Ag^{106m}. The beta transition to the second excited level was discussed in light of the new beta-decay selection rule. (auth)

12133 ON THE PROTONS FROM THE $N^{14}(d,p)N^{15}$ REACTION. Nawoyuki Kawai (Kyushu Univ., Fukuoka). J. Phys. Soc. Japan, 16: 157-65(Feb. 1961). (In English)

Angular distributions for the $N^{14}(d,p)N^{15}$ reaction were investigated at nine deuteron energies ranging from 1.5 to 3.2 Mev. Measurements were carried out in the angular range from 0 to 165 degrees at intervals of 15 degrees. The results for the $N^{14}(d,p)N^{15}$ ground state reaction showed generally a forward peak, as was expected from deuteron stripping, and a considerable rise in backward directions. These experimental data were analyzed with the heavy particle stripping theory and parameters adjusted to get a best fit were obtained. With the exception at forward directions, the main feature of angular distributions was found to be very similar to that for the $N^{14}(d,n)O^{15}$ ground state reaction, which is the mirror reaction, at the same deuteron energies. At forward directions proton yields from the $N^{14}(d,p)N^{15}$ reaction were substantially larger than neutron yields from the $N^{14}(d,n)O^{15}$ reaction. Angular distributions for the first excited doublet state reaction were found to be nearly isotropic, but a slight peak was observed at about 60 degrees similarly at all deuteron energies. Total cross sections for both state reactions were also estimated. Excitation functions for the $N^{14}(d,p)N^{15}$ and $N^{14}(d,n)O^{15}$ ground state reactions showed similar behavior, having some resonance-like structures. (auth)

12134 INELASTIC SCATTERING OF NEUTRONS BY THE TIME-OF-FLIGHT METHOD. Kineo Tsukada, Shigeya Tanaka, and Michio Maruyama (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 166-75(Feb. 1961). (In English)

Neutrons scattered by Ti, Fe, Zn, and Se have been observed by the time-of-flight technique in the energy range of 3.4 to 4.6 Mev. The inelastic scattering cross sections for the excitations of the 1st, 2nd, and 3rd levels of these elements except Se were obtained. The excitation functions of these levels were compared with those calculated with a formula which was made by modifying Hauser-Feshbach's formula so as to be used without detailed knowledge about the levels of high excitation. Agreement was fairly well except for the case of the 2nd and 3rd levels of Zn, where calculated values were about twice as large as experimental values. Thus it has been concluded that the compound-formation process is considered to predominate over the direct process in these energy and mass regions. (auth)

12135 ON THE INELASTICITY IN HIGH-ENERGY NUCLEAR INTERACTIONS. Shigeo Matsumoto and Shoji Mikamo (Osaka City Univ.). J. Phys. Soc. Japan, 16: 350-1(Feb. 1961). (In English)

An estimate of <K>, the average value of inelasticity, was made for high-energy nucleons. The expression $\langle K\rangle \approx 1.5 \langle n_\pm\rangle \langle E\rangle/2(\langle\gamma_c\rangle - 1)\ Mc^2$ was used, where $n_\pm$ is the average number of charged mesons produced, <E> its average total energy in the center-of-mass system, γ_c is the Lorentz factor of nucleons having average primary energy, and M is nucleon mass. To obtain $n_\pm$ a stack of emulsions was flown at 29 km, and 54 interactions by singly charged particles and 12 interactions by neutral particles were detected by the tracing-back method. Neglecting π-meson contamination, a value of $\langle n_\pm\rangle$ of 3.5 at an average energy of 26 Mev was obtained. For interactions of less than 6 $(N)_h$ heavily ionized prongs, the value was 2.8. A value of 0.44 Bev was taken for <E>, which gave a value of 0.34 for <K> of interactions with $N_h \leq 5$. It is concluded that <K> does not change greatly with increasing energy at least up to several tens of Bev. (T.R.H.)

12136 INTERACTION OF GAMMA RADIATION WITH MATTER. V. Lakshminarayana and Swami Jnanananda (Andhra Univ., Waltair, India). J. Sci. Ind. Research (India), B, 20: 1-7(Jan. 1961).

Total atomic cross sections for γ rays from Co^{60}, Sc^{46}, Cs^{134}, Cs^{137}, Cr^{51}, and Ce^{141} in elements C, Al, Cu, W, and Pb are determined with a modified narrow beam geometry, using a scintillation detector of good figures of merit. Theoretical cross sections are computed and compared with experimental results. Good agreement is observed for light elements at energies greater than 662 kev. Deviations are observed for light elements at lower energies and for heavy elements at all energies. In the case of light elements, the deviations are ascribed to the errors in theoretical evaluation of scattering cross sections. (auth)

12137 RESONANCE REACTIONS. P. M. Endt (Rijksuniversiteit, Utrecht). Nuclear Instr. & Methods, 11: 3-6(Jan. 1961). (In English)

The experimental conditions are discussed for the observation of reactions proceeding through narrow isolated resonances. This includes a survey of γ-ray resonant scattering or absorption techniques, making use of accelerator-produced radiation. This general introduction is followed by some examples of recent Utrecht work on resonance reactions. The $Na^{23}(p,\gamma)Mg^{24}$ reaction was investigated at six resonance levels in the E_p = 300 – 800 kev region. The γ-ray branching was determined of these levels and of twelve lower levels in Mg^{24}. Gamma-ray angular distributions were measured at nine resonances in the $Mg^{24}(\alpha,\gamma)Si^{28}$ reaction, from which resonance spins and parities can be determined in a unique way. Isotopic spin selection rules explain the relative weakness of observed E1 and M1 transitions compared to E2 transitions. From yield measurements in the $Al^{27}(p,\gamma)Si^{28}$, $Al^{27}(p,\alpha)Mg^{24}$, and $Mg^{24}(\alpha,\gamma)Si^{28}$ reactions the partial widths were obtained for the decay of the relevant Si^{28} resonance levels. (auth)

12138 THE GENERATION OF POSITRONS IN A THICK TARGET BOMBARDED BY FAST ELECTRONS. L. Katz (Univ. of Saskatchewan, Saskatoon) and K. H. Lokan. Nuclear Instr. & Methods, 11: 7-13(Jan. 1961). (In English) (AERE-R-3480)

An approximate analytical solution is developed for the distributions in energy and angle of positrons generated by fast electrons incident on a thick radiator (≈ 0.2 radiation lengths). For small angles, the positron energy spectrum may be expressed generally as a function of target thickness, incident electron energy, and a generalized shape function, which is tabulated. Numerical estimates of the energy distributions in the forward direction, arising from 25- and 100-Mev electrons incident on a radiator of thickness 0.2 radiation lengths, are made and compared with spectra measured at these energies; the agreement is satisfactory. (auth)

12139 COULOMB EXCITATION. Torben Huus (Univ. of Copenhagen). Nuclear Instr. & Methods, 11: 19-28(Jan. 1961). (In English)

Recent work on Coulomb excitation is surveyed by means of reproductions of a table and several figures which have appeared in papers published within the last year, or were available in the form of preprints. The table summarizes the various approximations that have been employed in the theoretical description of the process. The figures illustrate the information obtained from the excitation of collective nuclear states. (auth)

12140 DIRECT INTERACTION EJECTION IN THE REACTION $Be^9(n,2n)Be^8$. Roger Balian and Vincent P. Gillet (Centre d'Études Nucléaires, Saclay, France). Nuclear Phys., 17: 448-67(1960). (CEA-1747). (In French)

Methods of direct interaction were applied to the study of ejection reactions, which end into a 3-particle channel. General expressions for cross sections are given. Application was made to the reaction $Be^9(n,2n)Be^8$ up to 14 Mev, for which the contribution of the ejection process must be important, due to the low binding energy of the last nucleon of Be^9. Energies of 0.5 and 5 Mev for outgoing neutrons were found to be favored. Contributions of various regions of interaction were separately analyzed, and the reaction was found to take place mainly outside the core of Be^9. The cross section, calculated through ejection mechanism, together with compound nucleus results for low energy, agreed well with experimental data. If a break-up process is considered instead of the compound one, the agreement is less satisfactory. (auth)

12141 PHOTODISINTEGRATION OF Al^{27}. I. PHOTONEUTRON CROSS SECTION. J. E. E. Baglin, M. N. Thompson, and B. M. Spicer (Univ. of Melbourne). Nuclear Phys., 22: 207-15(Jan. 1961). (In English)

The $Al^{27}(\gamma,n)$ cross section was observed up to 18.5 Mev with good resolution. It contains a plateau at 14 Mev and a hump at 16 Mev and is consistent with recent high-resolution measurements of the total absorption cross section. (auth)

12142 PHOTODISINTEGRATION OF Al^{27}. II. THEORETICAL. J. E. E. Baglin, M. N. Thompson, and B. M. Spicer (Univ. of Melbourne). Nuclear Phys., 22: 216-25 (Jan. 1961). (In English)

The intrinsic-level scheme calculated for a deformed nucleus by Nilsson was used in conjunction with a single-particle excitation model to compute the photonuclear electric dipole absorption cross section for Al^{27}. The resultant curve contains peaks at 16, 18.5, and 21 Mev, in accord with the high-resolution experimental results of Mihailovic. The calculated energy distribution of photoneutrons contains high-energy direct-emission groups, in agreement with experiment. Angular distributions computed also agree with experimental results. A new small cross-section peak is predicted near 26 Mev. (auth)

12143 RESONANCE ENERGIES AND HALF-WIDTHS FOR PROTON CAPTURE IN SODIUM AND PHOSPHORUS. S. L. Andersen, O. Dørum, E. Gautvik, and T. Holtebekk (Univ. of Oslo). Nuclear Phys., 22: 245-8(Jan. 1961). (In English)

The γ-ray yield from proton-induced reactions in sodium and phosphorus was studied in the proton energy range between 0.7 and 1.5 Mev for sodium and in the energy range between 0.8 and 1.6 Mev for phosphorus. One new resonance in P^{31} at 1395.8 ± 0.7 kev is found. Relative determinations of the resonance energies are made with an accuracy of 0.05 to 0.1%. For 13 of the resonances in sodium and one of the resonances in phosphorus, the half widths are determined. For the rest of the resonances, upper limits for the half widths between 200 and 750 ev are determined. (auth)

12144 CORRECTIONS TO NUCLEAR Q VALUES RESULTING FROM ATOMIC BINDING AND EXCITATION. Robert F. Christy (California Inst. of Tech., Pasadena). Nuclear Phys., 22: 301-5(Jan. 1961). (In English)

Corrections to the measured energies of nuclear reactions associated with the binding and excitation of atomic electrons are calculated. (auth)

12145 ANGULAR DISTRIBUTIONS OF PHOTOELECTRONS EJECTED FROM URANIUM BY 1.118 MEV GAMMA RAYS. Sölve Hultberg, Tom O'Connor, and Joseph H. Hamilton (Vanderbilt Univ., Nashville). Nuclear Phys., 22: 306-15(Jan. 1961). (In English)

At a γ-ray energy of 1118 kev, longitudinal angular distributions of photoelectrons ejected from the K, L, and M+N+ ... shells of uranium were studied. The application of these angular functions to the calculation of the photoelectric correction factor f is discussed. It is important to obtain f at an energy such as 1.118 Mev to increase the accuracy, around 1 Mev, in the curve of f vs. energy. A smooth-curve relationship, in a log-log diagram was found between the γ-ray energy $h\nu$ and the angle θ_m of maximum photoelectric cross section. It is pointed out that the Swedish computer BESK now undertakes calculations of f at four γ-ray energies: 412, 662, 1118, and 1332 kev (assuming rectangular symmetry and taking source size into account). This new calculation increases the accuracy of f values such that the over-all accuracy in f between 400 and 1400 kev is now considered to be of the order of 1%. (auth)

12146 INELASTIC SCATTERING FROM Th^{232} AND U^{238}. E. Z. Skurnik, B. Elbek, and M. C. Olesen (Univ. of Copenhagen). Nuclear Phys., 22: 316-17(Jan. 1961). (In English)

The reduced electric quadrupole transition probabilities and excitation energies of the first excited states in Th^{232} and U^{238} were determined from inelastic-scattering measurements with protons and deuterons. (auth)

12147 THE HIGH ENERGY OPTICAL MODEL AND NUCLEAR FORCES. J. Dabrowski (Univ. of Washington, Seattle and Inst. for Nuclear Research, Warsaw) and J. Sawicki. Nuclear Phys., 22: 318-35(Jan. 1961). (In English)

An iteration procedure is discussed for the integral equation relating the t matrix for two nucleons in the medium to the free nucleon-nucleon t matrix. The real and imaginary parts of the medium- and high-energy

optical-model potential are discussed from the point of view of this procedure. Numerical results are obtained for the Gammel-Thaler and Signell-Marshak potentials. (auth)

12148 THE PERSISTENCE OF NUCLEAR POLARIZATION PRODUCED BY THE CAPTURE OF POLARIZED THERMAL NEUTRONS. A. H. Wapstra and D. W. Connor (Argonne National Lab., Ill.). Nuclear Phys., 22: 336-8 (Jan. 1961). (In English)

The relation between observed β asymmetry and the static magnetic guide field is investigated for the capture of neutrons by Li^7, F^{19}, and Al^{27}. (auth)

12149 ON THE DECAY OF BARIUM 129. Edvin Arbman and Inga Britt Hiller (Univ. of Uppsala). Nuclear Phys., 22: 341-52(Feb. 1961). (In English)

The internal conversion and positon spectra of Ba^{129} have been studied with a double focusing beta-ray spectrometer. Positons of energies 1425 ± 15 kev, 1243 ± 35 kev, and 975 ± 60 kev with relative intensities of 780, 240 and 60, respectively, were found. More than 60 transitions are identified from internal conversion lines. The decay of positons and a large number of conversion lines was followed in the spectrometer. A half life of 2.61 ± 0.02 hr was found for the positons, and half lives ranging from 2.00 ± 0.10 to 2.37 ± 0.08 hr were measured for various conversion lines. About 6% of Ba^{129} was found to decay by positons. The observations are interpreted as a consequence of isomerism in Ba^{129}. (auth)

12150 ANTIPROTON ANNIHILATIONS IN COMPLEX NUCLEI. A. G. Ekspong, Å. Frisk, S. Nilsson, and B. E. Ronne (Univ. of Uppsala and Univ. of Stockholm). Nuclear Phys., 22: 353-409(Feb. 1961). (In English)

An investigation of 356 antiproton annihilations in nuclear emulsion is reported. The results are generally analyzed to yield information on primary processes, assumed to be annihilations with single protons or neutrons into a number of pions with or without a K-meson pair. The average pion multiplicity is 4.68 ± 0.12 for annihilations at rest and 5.11 ± 0.12 for annihilations in flight (the antiproton energy being on the average of 166 Mev). This increase of 0.4 ± 0.2 pion is to be compared with an expected average increase of 0.1 pion. The pion energy distributions are given with mean values of 391 ± 10 Mev total energy (at rest) and 390 ± 9 Mev (in flight). Emission of K-meson pairs is found to take place in 3 ± 2% of the annihilation reactions. The average number of pions emitted together with K-mesons is 2.2 ± 0.5. The correction for K-meson pairs unobservable in usual emulsion experiments has been computed. The result that about 40% of the K-meson pairs are undetectable means that the correction for detection efficiency is larger than previously assumed. A recalculation of all published data using emulsion detectors results in a world average of 5.0 ± 1.1% of the annihilations with K-meson pairs for annihilations at rest and in flight (antiproton energy below 250 Mev). The annihilation probability at rest with neutrons is found to be less than that with protons on the basis of a determination of the number of stars with an odd number of charged pions relative to that with an even number. The odd/even ratio is 0.73 ± 0.09. The reabsorption probability of the pions in complex emulsion nuclei is determined. It is found that, on the average, 18% of the pions at rest and 32% of the pions in flight are absorbed. The difference is understood as a result of the movement of the center of momentum and the penetration of the antiprotons into the nuclei for the cases produced in flight. Comparison of the experimental results with the predictions of various theories is carried out. For the pion production, however, no decision in favor of a particular theoretical model can be made. As regards the production of K-mesons, all theories fail to predict the experimentally found production frequency. The world data on antiproton annihilations are collected, reanalyzed, and discussed. (auth)

12151 ON THE 5.16 MeV AND 7.56 MeV STATES OF B^{10}. W. W. True and E. K. Warburton (Princeton Univ., N. J.). Nuclear Phys., 22: 426-33(Feb. 1961). (In English) (PUC-1960-18)

The methods developed by Talmi and coworkers are used to calculate the binding energies of the two B^{10} levels formed by coupling $2S_{1/2}$ to the Be^8 ground state. The calculated energies are found to be in excellent agreement with those of the B^{10} 5.16- and 7.65-Mev levels, for which the most probable spin-parity and isobaric-spin assignments are $J^\pi = 1^+$, $T = 0$, and $J^\pi = 0^+$, $T = 1$, respectively. The strong γ-transition connecting these levels is also consistent with the proposed identification with double-particle excitation into the 2S–1d shell. The excitation energies of $2S_{1/2}$ levels in Be^{10}, B^{11}, and C^{12} are also calculated assuming that the Be^8 ground state forms an inert core. (auth)

12152 ON THE EFFECTIVE INTERACTION IN FINITE NUCLEI. B. Bremond (Faculté des Sciences, Orsay, France). Nuclear Phys., 22: 434-8(Feb. 1961). (In English)

The expectation values of the two nucleons interaction are calculated using Brueckner's matrix and shell model wave functions. These values are compared with phenomenological ones. The discrepancies can be explained by the effected approximations. (auth)

12153 MASS AND CHARGE DISTRIBUTION IN HIGH ENERGY INDUCED FISSION. Gösta Rudstam and Alexis C. Pappas (CERN, Geneva). Nuclear Phys., 22: 468-83(Feb. 1961). (In English)

Low-energy fission data have been used to estimate the symmetric fission probability and its energy dependence. By the use of this function, together with characteristics of symmetric and asymmetric fission modes, the mass and charge distributions in high-energy-induced fission have been obtained. A numerical calculation of the mass distribution to be expected in the fission of uranium with 170-Mev protons gives reasonable agreement with experimental results, and the extrapolations from low-energy data seem justified. The mass dependence of the apparent neutron-to-proton ratio of the most probable primary fission fragment and of the width of the charge distribution have therefore been estimated. A comparison with experimental data shows that neither the hypothesis of unchanged charge distribution nor that of equal charge displacement alone can explain the observed trends, but it suggests a mass dependent mixture of both. (auth)

12154 SYSTEMATICS OF $(\gamma,2n)$ REACTIONS. I. C. Nascimento, G. Moscati, and J. Goldemberg (Universidade de São Paulo, Brazil). Nuclear Phys., 22: 484-91(Feb. 1961). (In English)

The (γ,n) and $(\gamma,2n)$ cross sections in I^{127} and Au^{197} were measured from threshold up to 22 Mev. A comparison is made between the experimental result and the evaporation theory. Other data available in the literature are included. (auth)

12155 NEUTRON ANGULAR DISTRIBUTIONS FOR THE REACTION $O^{16}(He^3,n)Ne^{18}$. N. H. Gale, J. B. Garg, and K. Ramavataram (The University, Manchester, Eng.). Nuclear Phys., 22: 500-4(Feb. 1961). (In English)

The angular distributions of neutrons leading to the ground state of Ne^{18} in the reaction $O^{16}(He^3,n)Ne^{18}$ have been meas-

ured at bombarding energies of 5.6 and 6.09 Mev, using a pulsed beam time-of-flight neutron spectrometer. The angular distributions were found to be strongly peaked in the forward direction. The results have been compared with a double-stripping theory, and good agreement has been obtained with the theoretical prediction for $l = 0$ stripping. However, from the angular distributions alone, it is impossible to exclude the possibility that the reaction proceeds by a knock-out mechanism. If the mechanism is that of double stripping, the results lead to the assignment of spin zero and even parity to the ground state of Ne^{18}, in accordance with expectation. (auth)

12156 LIFETIMES OF THE 668-KEV AND 961-KEV EXCITED STATES IN Cu^{63}. T. Rothem, F. R. Metzger, and C. P. Swann (Franklin Inst., Swarthmore, Penna.). Nuclear Phys., 22: 505-12(Feb. 1961). (In English)

The 668-kev and 961-kev levels of Cu^{63} have been studied by the resonance scattering method. The levels were excited by the gamma radiations from gaseous and from liquid sources of Zn^{63}, and both the resonance effect and the angular distribution of the scattered radiations have been measured. Fitting the data to a distribution of the form $W(\theta) = 1 + A_2P_2(\cos\theta)$ yielded the values -0.03 ± 0.07 and 0.8 ± 0.2 for A_2 in the case of the 668-kev and 961-kev lines, respectively. Assuming spin $\frac{1}{2}$ for the 668-kev level, its mean life was measured to be $(3.1 \pm 0.3)\ 10^{-13}$ sec. The mean life of the 961-kev level was found to be $(9 \pm 1.5)\ 10^{-13}$ sec, assuming a spin of $\frac{5}{2}$. (auth)

12157 GAMMA-RAY SPECTRA FROM CAPTURE OF FAST NEUTRONS. I. Bergqvist and N. Starfelt (Research Inst. of National Defence, Stockholm). Nuclear Phys., 22: 513-23(Feb. 1961). (In English)

A method to study the spectrum of the gamma rays emitted in radiative capture of fast neutrons has been developed. A sodium iodide scintillation spectrometer was employed, and the use of time-of-flight techniques made it possible to reduce the background of scattered neutrons sufficiently. Nickel, silver, and gold were studied with 0.1-Mev neutrons, and a comparison with the gamma-ray spectra from the capture of thermal neutrons was made. The agreement was good for nickel and silver. In the case of gold the relative intensity of the high-energy gamma rays was lower for 0.1-Mev neutrons than for thermal neutrons. (auth)

12158 NUCLEAR OCTUPOLE DEFORMATION AND THE MECHANISM OF FISSION. Sven A. E. Johansson (Univ. of Lund, Sweden). Nuclear Phys., 22: 529-52 (Feb. 1961). (In English)

The stability of nuclei against an octupole deformation was calculated. It was found that the interaction of levels of opposite parity makes the nuclei in certain regions very soft to octupole deformation. The negative parity collective states in heavy nuclei and in the rare-earth region can be interpreted as octupole vibrations. The predicted A-dependence of the energy of these states agrees well with experimental data. For very elongated shapes, which are of interest in fission, it was found that stable octupole deformation occurs. The potential surface of the fission barrier would therefore possess two asymmetric valleys. There is a linear relationship between the mass ratio of the fission fragments and the degree of octupole deformation at the saddle point. The occurrence of symmetric fission in the lighter elements is explained. The influence of the octupole deformation on the fission barrier also provides a basis for understanding the variation in fission threshold. The experimental data agree with the calculated values. The peak to valley ratio in the mass distribution was calculated, with the assumption of statistical equilibrium at the saddle point. Good agreement was found for excitation energies below 10 Mev. For higher energies a symmetric component appeared which rose with increasing energy. (auth)

12159 PARTIAL-SYMMETRIES OF WEAK INTERACTIONS. Sheldon L. Glashow (Univ. of Copenhagen). Nuclear Phys., 22: 579-88(Feb. 1961). (In English)

Weak and electromagnetic interactions of the leptons were examined under the hypothesis that the weak interactions are mediated by vector bosons. With only an isotopic triplet of leptons coupled to a triplet of vector bosons (two charged decay intermediaries and the photon), the theory possesses no partial symmetries. Such symmetries may be established if additional vector bosons or additional leptons are introduced. Since the latter possibility yields a theory disagreeing with experiment, the simplest partially symmetric model reproducing the observed electromagnetic and weak interactions of leptons requires the existence of at least four vector-boson fields (including the photon). Corresponding partially conserved quantities suggest leptonic analogs to the conserved quantities associated with strong interactions: strangeness and isobaric spin. (auth)

12160 GEOMETRICAL REPRESENTATION OF NUCLEAR PROPERTIES. M. Beiner and K. Bleuler (Univ. of Bonn). Nuclear Phys., 22: 589-97(Feb. 1961). In English)

Experimental nuclear data are represented with the help of a geometrical method, which allows a comprehensive survey of nuclear properties and a more direct comparison with theoretical results. The separation energies (for protons and neutrons) defined in a suitable way were considered. These values (for all nuclei so far measured with sufficient accuracy) were represented by two surfaces in 3-dimensional space. Immediately some striking features of the general behavior of these surfaces were observed: well-pronounced shell structure effects in the middle part of the periodic table (energy steps after the closing of each shell), a typical discontinuity for $N = 90$ corresponding to the well-known sudden deformation of nuclear shape, and effects of complex structure for lighter elements. With the help of these diagrams, a method is given for the representation of single-particle states of odd-mass nuclei. (auth)

12161 LEVELS IN Gd^{156} FED BY THE DECAY OF 15-DAY Eu^{156}. J. E. Cline and R. L. Heath (Phillips Petroleum Co., Idaho Falls, Idaho). Nuclear Phys., 22: 598-609(Feb. 1961). (In English)

Radiations following the decay of 15-day Eu^{156} were studied by using the techniques of coincidence scintillation spectrometry and 4π beta counting. Twenty-eight γ rays were identified as transitions from excited levels in Gd^{156}. The energies of these γ rays along with their coincidence relationships, indicate that levels are present in the daughter nuclide at 89, 290, 520, 1150, 1240, 1250, 1320, 1360, 1960, 2030, 2180, and 2200 kev. Gamma-gamma directional correlation measurements were made leading to spin assignments for the levels at 1320, 1960, and 2030 kev. (auth)

12162 NEGATIVE PARITY LEVELS IN THE EVEN-EVEN NUCLEUS Dy^{160}. G. T. Ewan, R. L. Graham, and J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys., 22: 610-28(Feb. 1961). (In English)

The conversion electron spectrum of Tb^{160} was studied in the Chalk River air-cored $\pi\sqrt{2}\ \beta$ spectrometer at resolution settings of 0.04 to 0.1%. Gamma-conversion electron coincidence experiments were made to establish the posi-

tions of the levels in Dy^{160}. The level scheme based on the present results is 0 (0+), 86.7 (2+), 283.6 (4+), 965.8 (2+), 1048.8 (3+), 1264.4 (2−), 1286.5 (3−), 1358.2 (2−), and 1398.5 kev (3−). This is similar to that of Nathan in the positive-parity levels but differs in the negative parity levels. Particular attention was paid to determining the intensities of weak transitions in the decay scheme. The relative quantum transition probabilities were deduced from the conversion line measurements by using Sliv's theoretical conversion coefficients. The agreement between the observed transition probabilities from the positive-parity levels and the theoretical predictions of the Unified Model was greatly improved when a small amount of K = 0 band was assumed mixed in the K = 2 gamma-vibrational band. The relative transition probabilities from the negative parity levels were not consistent with K being a good quantum number in discussing these levels. The possibility of interaction between the negative parity levels is briefly discussed. (auth)

12163 NEUTRON TOTAL CROSS-SECTIONS IN THE ENERGY RANGE 16 TO 120 MEV. P. H. Bowen (Atomic Energy Research Establishment, Harwell, Berks, Eng.), J. P. Scanlon, G. H. Stafford, J. J. Thresher, and P. E. Hodgson. Nuclear Phys., 22: 640-62(Feb. 1961). (In English)

A neutron time-of-flight spectrometer was used to measure the neutron total cross sections of H, C, Al, Cu, Cd, Pb, and U at 64 energies in the range 15 to 120 Mev. The results were compared with previous work in this energy range and were analyzed in terms of the optical model of the nucleus. (auth)

12164 EFFECTIVE MOMENTS IN K^{39} AND K^{40}. A. De-Shalit (Stanford Univ., Stanford, Calif.). Nuclear Phys., 22: 677-88(Feb. 1961). (In English)

Important information on the effective moments of found nucleons can be obtained by comparing magnetic moments of levels belonging to the same nucleon configuration in an odd-odd nucleus, or M1 transitions between such levels. This analysis was carried out for K^{40}, and the results agree very well with the magnetic moment of K^{39}. An attempt was made to include the effects of configuration mixing in K^{40}, induced by the residual proton-neutron interaction. A δ type interaction that reproduces the spectrum of Cl^{38} was assumed. The resulting agreement was considerably deteriorated, indicating that such an admixture of configurations is probably negligible in K^{40}. Further experiments are suggested to check the validity of the concept of an effective moment. (auth)

12165 CONCERNING THE DECAY OF Se^{75}. E. P. Grigor'ev (Grigoriev) and A. V. Zolotavin (Leningrad State Univ.). Nuclear Phys., 22: 689-91(Feb. 1961). (In English)

No lines corresponding to the 188 and 203 kev were detected in the internal and external conversion spectrum of Se^{75}. (auth)

12166 ANGULAR DISTRIBUTION OF THE $V^{51}(n,d)Ti^{50}$ GROUND STATE DEUTERONS. I. Slaus, P. Tomaš, and N. Stipčić (Institute "Rudjer Bošković," Zagreb). Nuclear Phys., 22: 692-7(Feb. 1961). (In English)

The angular distribution of deuterons from the reaction $V^{51}(n,d)Ti^{50}$ was measured at the incident neutron energy of 14.4 Mev by means of a thin scintillator method. The data showed a pronounced maximum at 40°, indicating the predominance of the direct interaction process. A reasonable fit was obtained with a Butler $L_p = 3$ curve using $r_0 = 6.15 \times 10^{-13}$ cm. The reduced width was found to be 0.03. (auth)

12167 ETA OF U^{233} FROM 1 TO 800 ev. M. L. Yeater, R. W. Hockenbury, and R. R. Fullwood (Rensselaer Polytechnic Inst., Troy, N. Y.). Nuclear Sci. and Eng., 9: 105-19(Feb. 1961).

Eta of U^{233} was measured in the energy range from 1 to 800 ev by counting fast fission neutrons in ZnS-loaded plastic scintillators. Incident neutron energies were measured in a time-of-flight system with a betatron as the pulsed source. The data were normalized at 1 ev to data reported at Geneva by the MTR group; the latter results were normalized to an absolute thermal value. Corrections were made for multiple scattering by a rigorous single velocity analysis and by a Monte Carlo calculation that also accounts for energy degradations. (auth)

12168 GAMMA BRANCHING IN Kr^{85}. W. S. Lyon (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 9: 148-50(Feb. 1961).

Kr^{85} decays directly to the ground state by 0.67-Mev maximum β emission in greater than 99% of the decay. The fraction of the decay which proceeds through a lower energy β emission (~0.16 Mev) followed by a γ transition of 0.514 Mev was determined by measurement of the number of 0.513-Mev γ rays per β disintegration. This γ/β ratio measured by γ-scintillation spectrometry and absolute β counting techniques was found to be 0.0038 ± 0.0003. (auth)

12169 PARENT ACTIVITY FROM DAUGHTER GROWTH. Yizhak Marcus (Atomic Energy Commission Lab., Rehovoth, Israel). Nucleonics 19: No. 3, 76(Mar. 1961).

A method is given for calculating the activity of a long-lived parent from the growth of a daughter with a short half life. In this method, the daughter activity is plotted vs. time on one graph and compared with a calculated curve until the best fit is found. In this way, daughter equilibrium activity can be determined from data extending over little more than one half life of the daughter, the moment of separation can be determined, and the daughter half life can be approximated by using a family of curves plotted with half life as a parameter. This method is applied to the growth of Bi^{210} in a sample of initially pure Pb^{210}. (D.L.C.)

12170 NEUTRON THRESHOLD REACTIONS—AN INTERCOMPARISON. C. E. Mellish (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucleonics 19: No. 3, 114-15(Mar. 1961).

Some of the published threshold cross section data from nine sources are tabulated for six fast neutron reactions of the type (n,p) and (n,α). After adjustment to a value of 60 mb for the $S^{32}(n,p)$ reaction, the data show good agreement with each other with ~10% standard deviation, three sources being excepted. The following fast reactor cross sections are given as the most probable values: S^{32} (n,p), 60 mb (assumed); $P^{31}(n,p)$, 31 mb; $Al^{27}(n,\alpha)$, 0.56 mb; $Ni^{58}(n,p)$, 105 mb; $Fe^{54}(n,p)$, 47 mb; and $Fe^{56}(n,p)$, 0.87 mb. (D.L.C.)

12171 THEORY OF LOW ENERGY NUCLEON-NUCLEON SCATTERING. II. HIGH WAVES. D. Amati, E. Leader, and B. Vitale (CERN, Geneva). Nuovo cimento (10), 18: 409-29(Nov. 1, 1960). (In English)

A theory previously developed for low-energy N-N scattering was applied to the special case of high waves. The distinction between high and low waves is discussed. It is hoped that the formulas given will yield a valid representation of the nucleon-nucleon partial-wave amplitudes for values of the orbital momentum $l \geq 2$. For these high waves the cut in the energy plane due to three pion or more massive intermediate states is supposed to give a negligible contribution. In this case the representation reduces to a

set of explicit formulas for the partial-wave amplitudes. These formulas contain explicitly the effect of the Born term and rescattering corrections in pion-nucleon scattering as well as the effect of a possible pion-pion interaction. (auth)

12172 THEORY OF LOW ENERGY NUCLEON-NUCLEON SCATTERING. III. PARTIAL WAVE INTEGRAL EQUATIONS FOR LOW ORBITAL MOMENTUM AMPLITUDES. D. Amati, E. Leader, and B. Vitale (CERN, Geneva). Nuovo cimento (10), 18: 458-65(Nov. 1, 1960). (In English)

The theory of low-energy N-N scattering developed previously was applied to the low orbital momentum scattering amplitudes. Integral equations for these amplitudes were constructed, and the entire two-meson contribution to the left-hand cut is explicitly given in terms of the effect of the Born term and 3, 3 resonance in pion-nucleon scattering and a possible π-π interaction. The contributions to the cut from higher-mass intermediate states were assumed to be given by a low-order polynomial in the energy, the coefficients of which will apear as phenomenological constants in the theory. The integral equations are exactly of the form treated recently by Noyes. This may be regarded as a specification of the left-hand cut discontinuity to be used in those equations, the solutions of which should give the energy variation of the low partial waves. (auth)

12173 INELASTIC ELECTRON SCATTERING AND NUCLEAR COMPRESSIBILITY. L. J. Tassie (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo cimento (10), 18: 525-31(Nov. 1, 1960). (In English)

The form factors for the electron excitation of vibrational and rotational collective nuclear transitions were obtained, assuming the nucleus is incompressible, and compared with the experimental and theoretical results of Helm. The inelastic scattering of high-energy electrons can be used to investigate nuclear compressibility. (auth)

12174 INELASTIC SCATTERING OF HIGH ENERGY PHOTONS IN THE COULOMB FIELD OF A NUCLEUS WITH PRODUCTION OF ELECTRON-POSITRON PAIRS (RADIATIVE PAIR PRODUCTION). B. De Tollis (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome), G. Jona Lasinio, and R. S. Liotta. Nuovo cimento (10), 18: 545-53(Nov. 1, 1960). (In English)

Radiative pair production was studied, and the differential cross sections for two kinematical cases are given. The cross sections for the case in which pair, electron, and positron with the same momentum were emitted forward and the scattered photon emitted at an angle θ and when the photon was emitted in the forward direction, the pair, still electron and positron with the same momentum, was emitted at an angle θ, were measured. The calculations were performed with the standard perturbative theory in Born approximation. For small angle θ and for incident γ energy available from modern synchrotrons, the two cross sections were sufficiently high so that they could be measured. (auth)

12175 ANGULAR CORRELATION OF ANNIHILATION RADIATION IN SILICA AND AQUEOUS SOLUTIONS. P. Colombino (Università, Turin), I. Degregori, L. Mayrone, L. Trossi, and S. DeBenedetti. Nuovo cimento (10), 18: 632-43(Nov. 16, 1960). (In English)

A description is given of the experimental apparatus that was used to study the angular distribution of γ rays from positron annihilation. The results of measurements carried out on various forms of silica and on aqueous solutions of several salts are discussed. (auth)

12176 TOTAL NEUTRON CROSS-SECTION OF P AND S IN THE 3 TO 5 Mev ENERGY RANGE. P. Cuzzocrea, S. Notarrigo, R. Ricamo, and F. Vinci (Università, Catania, Italy and Centro Siciliano di Fisica Nucleare, Catania, Italy). Nuovo cimento (10), 18: 671-7(Nov. 16, 1960). (In English)

The total neutron cross sections of P and S were measured for neutron energies between about 3 and 5 Mev. Transmission measurements were made in steps of 25 to 30 kev, with a neutron energy spread of 30 to 60 kev. Neutrons were produced from the $^2D(d,n)^3He$ reaction with 2-Mev deuterons. Neutrons of various energies were obtained at various angles from the direction of the deuteron beam. The average total cross section of the two neighbor nuclei at 4 and 5 Mev suggests the opportunity of a refinement of the optical model. (auth)

12177 DEUTERON PRODUCTION IN PICK-UP REACTIONS. [PART] I. E. G. Beltrametti, L. Ciuffolotti, and G. Tomasini (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo cimento (10), 18: 678-87 (Nov. 16, 1960). (In English)

Some features of the deuteron production, by 120-Mev protons interacting in nuclear emulsions, are examined, which exhibit deviations from a simple independent particle model of the nucleus. The experimental results and the technique used to discriminate the deuterons are described. (auth)

12178 DEUTERON PRODUCTION IN PICK-UP REACTIONS. [PART] II. E. G. Beltrametti and G. Tomasini (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo cimento (10), 18: 688-701(Nov. 16, 1960). (In English)

An interpretation is presented of the production of deuterons with an energy spectrum and angular distribution that cannot be explained by an independent particle model pick-up process. Use of the two-nucleon, or quasi-deuteron, nuclear model is made, and a reasonable agreement with the experimental data is obtained. (auth)

12179 LIMITS ON IRREGULAR INTERACTIONS OF MUONS AND THEIR MANIFESTATION IN NUCLEAR DIFFUSION AT HIGH ENERGY. B. Jouvet and L. Goldzahl (College de France, Paris). Nuovo cimento (10), 18: 702-17(Nov. 16, 1960). (In French)

A determination, starting with recent experimental data (mesic atoms, magnetic moments), was made of the limits for the masses and coupling constants of bosons, scalar, vectorial, and pseudoscalar, which can be explained by the abnormal mass of the muon. Then the conditions for demonstration of an abnormal muon-nucleon interaction in elastic scattering on the nucleus are discussed. (tr-auth)

12180 AN UNIFIED THEORY OF DIRECT REACTIONS. A. Agodi and E. Eberle (Università, Catania, Italy and Centro Siciliano di Fisica Nucleare, Catania, Italy). Nuovo cimento (10), 18: 718-43(Nov. 16, 1960). (In English)

A new dispersion theory of nuclear reactions is presented which is a generalization of the existing ones. The theory is centered around the possibility of defining a class of problems equivalent to the original scattering problem in the sense that their solutions all determine the same transition matrix elements. These equivalent problems are generated by suitably projecting the original one on a subspace of the linear space spanned by the continuum eigenstates of the total hamiltonian, containing the initial and final channel states. A derivation of the Breit-Wigner formula analogous to Feshbach's can be given in the theory, independently of any configuration space representation. The direct processes are then defined by performing the energy average on the transition matrix elements, so that the contributions from the long-lived "compound" states are lost. In the

case of nucleon-nucleus scattering, this is shown to give an alternative definition of the optical model quite analogous to the conventional ones though perhaps more accessible to a field theoretical analysis. Moreover it is shown that the well-known surface contributions to direct reactions can be isolated quite naturally in the formalism from the other direct contributions. (auth)

12181 POLES IN PRODUCTION CROSS SECTIONS. R. Ascoli (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 18: 744-53(Nov. 16, 1960). (In English)

A study was made of the nature and position of the one-particle singularities that are expected in the production cross section $\partial^2\sigma/\partial w^2\,\partial\Delta^2$, introduced by Chew and Low, when considered as a function of the momentum transfer Δ^2. It is found that these singularities are in general in the complex Δ^2 plane. Furthermore a phenomenon analogous to the "anomalous thresholds" of the scattering processes is found. The phenomenon occurs only with strange particles or nuclei. In some cases it may prevent the application of the extrapolation procedure that has been proposed by Chew and Low to get scattering cross sections from production experiments. (auth)

12182 ANALYTIC PROPERTIES OF PRODUCTION AMPLITUDES AS FUNCTIONS OF TWO MOMENTUM TRANSFERS. R. Ascoli (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 18: 754-69(Nov. 16, 1960). (In English)

It is shown that, starting from the Dyson representation, it is possible to prove analytic properties of production amplitudes as functions of two dynamical variables at the same time. As such it is in particular possible to choose two invariant momentum transfers; the remaining variables which are held fixed are only subject to the restriction of determining completely the final momenta and may as well be covariant variables. There is no limitation to the number of final particles; there is only some simplification in the analyticity properties in the case of simple production. The research of the region of analyticity leads to an elegant mathematical problem. The solution of this problem leads to a region of analyticity which is the same in any case and consists of a finite domain in the space of the two complex variables; the domain includes always the physical region. (auth)

12183 POTENTIAL MODEL OF DEUTERON PHOTODISINTEGRATION AND MANDELSTAM REPRESENTATION. V. De Alfaro and C. Rossetti (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo cimento (10), 18: 783-805(Nov. 16, 1960). (In English)

The analytic properties of the fixed angular momentum amplitudes of the deuteron photodisintegration were investigated by a potential model. It is shown that these properties agree with those obtained by a Mandelstam representation with anomalous thresholds, as argued by perturbation arguments. This is an argument in favor of the validity of general dispersion techniques also in nuclear physics. (auth)

12184 DISPERSION RELATIONS FOR SOME PHOTON REACTIONS. A. Minguzzi and R. F. Streater (CERN, Geneva). Nuovo cimento (10), 18: 806-12(Nov. 16, 1960). (In English)

By using Dyson's integral representation directly for the absorptive part of the T matrix, certain dispersion relations involving photons and nuclei are proved more simply than by the method of Bogoliubov et al. The range of validity is always less than that obtained by the best possible techniques, but fewer physical assumptions are needed. In particular the existence of an interpolating field associated with light nuclei is not needed. In the usual e^2 approximation photoproduction, Compton scattering, and bremsstrahlung can be treated from nuclei. (auth)

12185 A MEASUREMENT OF THE DECAY OF ^{181}W. W. E. Kreger and R. L. Lynn (Naval Radiological Defense Lab., San Francisco). Nuovo cimento (10), 18: 829-36 (Dec. 1, 1960). (In English)

The half life of W^{181} which emits 59.2-kev x radiation following decay by orbital electron capture was measured to be (126.2 ± 3.2) days. The measurement was made using a source electromagnetically enriched in W^{180} before irradiation. In order to ensure that the possible low-energy radiation from W^{185} was not influencing the measurements, a calculation was made to show that this contamination was not a problem. An additional measurement on a natural tungsten source confirmed the results of the calculation. (auth)

12186 ANALYSIS OF SOME NUCLEAR INTERACTIONS OF ENERGIES $(10^{12} \div 10^{14})$eV/NUCLEON. P. K. Malhotra and Y. Tsuzuki (Tate Inst. of Fundamental Research, Bombay). Nuovo cimento (10), 18: 982-1002(Dec. 1, 1960). (In English)

Five nuclear interactions produced by nuclei with values of charge Z = 1, 2, 6, 7, and 14 and with energies between 10^{12} and 10^{14} ev/nucleon are described. The angular distributions and the momentum distributions of the secondary particles produced in these jets were studied. Assuming transverse momentum to be constant, the momentum spectrum in the c.m. system in the case of each of the three jets with energies between 10^{13} to 10^{14} ev/nucleon was found to be of the form $P^{-2}dP$. Twenty nuclear interactions produced by secondary particles arising in two of the jets which involved energies of about 10^{14} ev/nucleon were also analyzed. The ratio of the number of secondary interactions produced by neutral to that produced by charged particles is found to be 0.23 ± 0.15. The energies of the particles responsible for 16 of the secondary interactions were determined. The transverse momentum distribution of the secondary particles, produced in nucleon-nucleus and nucleus-nucleus collisions at $\sim 10^{14}$ ev/nucleon and emitted at small angles (i.e., belonging to the inner cone), was found to be consistent, in the cases studied, with that observed in nucleon-nucleon collisions at this energy. The observations indicate that nucleon-nucleus and nucleus-nucleus collisions at energies of about 10^{13} to 10^{14} ev/nucleon are, in general, similar to nucleon-nucleon collisions. (auth)

12187 ON THE DECAY OF Cs^{129}. S. Jha, H. G. Devare, and R. M. Singru (Inst. of Fundamental Research, Bombay). Nuovo cimento (10), 18: 1108-15(Dec. 16, 1960). (In English)

The radiations from the decay of Cs^{129} were investigated by β-ray and coincidence scintillation spectrometers. New γ rays of 790 and 920 kev were detected. The conversion coefficients of the γ rays and percentages of the electron captures to different excited states of Xe^{129} were estimated. A level scheme of Xe^{129} and the possible spin and parity assignments to different levels were suggested. (auth)

12188 K-CONVERSION COEFFICIENTS OF E2 TRANSITIONS. M. K. Ramaswamy (Ohio State Univ., Columbus). Nuovo cimento (10), 18: 1287-8(Dec. 16, 1960). (In English)

Pure E2 transitions of the type 0^+-2^+ in even-even nuclei were analyzed in the manner of Subba Rao, Nuovo cimento, 17: 189(1960). A table is given listing the energy

of the E2 transition, α_K experimental, α_K theoretical, $R(\alpha_K)$, the deformation parameter, and the value of $R(\alpha_K)$ for $2^+ - 0^+$ transition in the same nucleus taken from Subba Rao for Pd^{106}, Sm^{152}, Gd^{152}, and Er^{166}, the only nuclei for which α_K has been measured. It is observed that more cases are needed, and the ratios for $2^+ - 0^+$ and $0^+ - 2^+$ transitions in the same nucleus are consistent with the statistical errors. The value for Pd^{106} falls below unity which is compatible for other spherical nuclei listed by Subba Rao. (T.R.H.)

12189 NOTE ON THE PHOTOPARTICLES' ANGULAR DISTRIBUTION. A. Molinari (Università, Turin). Nuovo cimento (10), 18: 1298-1300(Dec. 16, 1960). (In English)

A remarkable difference between angular distributions of nuclear reactions and photo-reactions is pointed out. (T.R.H.)

12190 ELECTRIC FIELD GRADIENTS IN DILUTE ALLOYS OF SILVER. C. A. Giffels, G. W. Hinman, and S. H. Vosko (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 121: 1063-9(Feb. 15, 1961).

The directional correlation of the γ rays emitted in the decay of Cd^{111} was measured with the cadmium embedded in the cubic silver lattice in order to observe the electric field gradients produced by various solute atoms. The alloys studied contain small concentrations of Cd, In, Sn, Sb, or Ge. The results are compared to various theories of screening and are found to be in agreement with a cos $(2kr + \phi)/r^3$ fall off of shielding charge, where k is the wave number at the Fermi surface. (auth)

12191 DETECTION OF DOUBLE RESONANCE BY FREQUENCY CHANGE: APPLICATION OF Hg^{201}. Robert H. Kohler (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 121: 1104-11(Feb. 15, 1961).

A new type of double-resonance experiment that depends on wavelength effects rather than on polarization effects is discussed. Incident polarized light is replaced by incident light of wavelength coincident with just one component of the structure to be measured. The analyzer is replaced by a cell of gas that absorbs just that same component and lets the others pass. Magnetic resonance from the excited component to one of the others is monitored by increases in the light transmitted through the absorbing gas. This experiment requires that the Doppler width be smaller than the structure. This method was first applied to measure the hyperfine structure of the $^3P_1$ state of Hg^{201}. The incident light and absorbing gas were both supplied by separated Hg^{198}, whose resonance line coincides naturally with one component of the Hg^{201} hyperfine structure. Measurement of Hg^{201} is discussed in detail. Means for applying the method when there is no isotope coincidence are given. This new method is compared with the polarization technique and is found to give signal-to-noise ratios that are orders of magnitude higher. (auth)

12192 IONIZATION CROSS SECTIONS FOR PROTONS ON HYDROGEN GAS IN THE ENERGY RANGE 0.15 TO 1.10 MEV. J. W. Hooper, E. W. McDaniel, D. W. Martin, and D. S. Harmer (Georgia Inst. of Tech., Atlanta). Phys. Rev., 121: 1123-7(Feb. 15, 1961).

Measurements were made of the ionization cross section for protons incident on hydrogen gas in the energy range 0.15 to 1.10 Mev. The experimental cross section in this region can be represented by $\sigma_i = (3.45 \pm 0.20)$ $E^{-(0.874\pm0.010)} \times 10^{-17}$ cm^2/molecule, where E is the incident proton energy in Mev. (auth)

12193 α^3 CORRECTIONS TO HYPERFINE STRUCTURE IN HYDROGENIC ATOMS. Daniel E. Zwanziger (Columbia Univ., New York). Phys. Rev., 121: 1128-42(Feb. 15, 1961).

The α^3 term in the ratio of the hyperfine splitting in the 2S state of the one-electron atom to the hyperfine splitting in the 1S state was recalculated, and a new theoretical value for this ratio was obtained which is in agreement with the experimental value, thereby eliminating a previously reported discrepancy. The calculation consists in the evaluation of the low-momentum parts, of order α^3 hfs, of the expression for the lowest-order radiative level shift in the bound interaction representation with external Coulomb and magnetic dipole fields. By rearranging the terms so as to display the gage invariance of the matrix elements with respect to the external potentials, considerable simplicity was achieved, and the formulas are easily interpreted as a generalization of the expression for the lowest-order Lamb shift. The contribution from soft photon intermediate states was obtained. (auth)

12194 LOW-ENERGY PROTONS PRODUCED IN THE DEUTERON BOMBARDMENT OF NUCLEI. E. W. Hamburger, B. L. Cohen, and R. E. Price (Univ. of Pittsburgh). Phys. Rev., 121: 1143-9(Feb. 15, 1961).

When nuclei are bombarded by fast deuterons a continuous spectrum of protons is observed at energies corresponding to $Q < -2.2$ Mev. The shape and angular distribution of this continuum were studied for several targets, from lithium to gold, with 14.8-Mev deuterons. The angular distributions are strongly peaked at or close to 0° for light elements; for heavy elements the peak broadens and moves to ~ 50°. The energy spectra show peaks which, with increasing angle, move to lower energies for light elements to higher energies for heavy elements. All features of the results are explained using a semiclassical theory in which the deuteron is broken up in the external field of the nucleus. The breakup occurs at or near the nuclear surface for light elements, but quite far out from it in heavy elements. (auth)

12195 MEASUREMENT AND INTERPRETATION OF NEUTRON TOTAL CROSS SECTIONS OF CARBON, CALCIUM, AND LEAD. R. M. Wilenzick, G. E. Mitchell, K. K. Seth, and H. W. Lewis (Duke Univ., Durham, N. C.). Phys. Rev., 121: 1150-8(Feb. 15, 1961).

The neutron total cross sections of carbon, calcium, and lead were determined in the energy region 200 to 960 kev using a time-of-flight technique. The observed cross section for carbon was analyzed in terms of the effective-range theory as well as the bound-level contribution. It is concluded that the upper limit for the total width of the "proposed" resonance in C^{13} at 610 kev is 100 ev. For calcium and lead the data are analyzed for resonance parameters. It was found that the s-wave strength function for Ca^{40} increased rapidly with increasing energy. It was concluded also that the course of the lead cross sections can be explained only by the presence of a broad s-wave resonance in Pb^{208}. (auth)

12196 DECAY OF 16-MINUTE Ta^{182m}. A. W. Sunyar (Brookhaven National Lab., Upton, N. Y.) and P. Axel. Phys. Rev., 121: 1158-68(Feb. 15, 1961). (BNL-4863)

A revised decay scheme of the 16-min isomer Ta^{182m} involves three states of Ta^{182} at excitation energies of 147, 319, and 503 kev. Transition multipolarities were classified by measuring both γ-ray coincidences and internal conversion electrons. The 503-kev isomeric state decays mainly (98%) by a 184-kev E3 transition to the 319-kev state. This 319-kev state decays mainly (94%) to the 147-kev state by means of a 172-kev transition that is predominantly M1. The 147-kev transition to the ground state is also predominantly M1. Two of the three possible crossover transitions were observed; a 356-kev M4 transition

originates at the isomeric level and a 319-kev E2 transition connects the second excited state with the ground state. The 147-kev and the 319-kev states are probably the first and second excited rotational states of the ground-state configuration. The relevant rotational parameters are of particular interest because very little is known about moments of inertia for odd-odd nuclei. The relative probabilities were determined for pile neutron activation of the 16-min isomer, Ta^{182m}, and the 112-day ground state, Ta^{182}. (auth)

12197 NEW APPLICATION OF DELAYED COINCIDENCE TECHNIQUES FOR MEASURING LIFETIMES OF EXCITED NUCLEAR STATES—Ca^{42} AND Sc^{47}. P. C. Simms, N. Benczer-Koller and C. S. Wu (Columbia Univ., New York). Phys. Rev., 121: 1169-74(Feb. 15, 1961).

A new application of the delayed coincidence technique for measuring short nuclear lifetimes was developed which is basically similar to the well-known prompt comparison method. Systematic errors can be reduced and greater accuracy obtained for nuclei which exhibit both a prompt and a delayed event. A transistorized time-to-amplitude converter was used. The mean life of the second excited state of Ca^{42} and the first excited state of Sc^{47} were measured. Also the mean life of the first excited state of Hg^{198} was determined by the usual self-comparison method. (auth)

12198 BETA-GAMMA DIRECTIONAL CORRELATIONS IN THE DECAY $Sb^{124} \rightarrow Te^{124}$. Helmut Paul (Purdue Univ., Lafayette, Ind.). Phys. Rev., 121: 1175-9(Feb. 15, 1961).

The β-γ directional correlations involving the 1.6-Mev β group of Sb^{124} and the second excited 2^+ state of Te^{124}. Both of the γ rays (0.72 and 1.32 Mev) de-exciting this state were used. For both groups of γ rays, the results for the coefficient ϵ in $W(\theta) = 1 + \epsilon P_2(\cos\theta)$ are evaluated. From the results, the mixing ratio for the 0.72-Mev γ ray is found. It is shown that the 1.6-Mev β transition must be due, at least partly, to the B_{ij} matrix element. By assuming $u = x = 0$ (in Kotani's notation), the data can be fitted by either $Y/z = 0.04$ (i.e., an essentially unique transition) or $Y/z = 1.2$. Evidence for the existence of a 1.25-Mev level in Te^{124} is also given. (auth)

12199 ASYMMETRIC FISSION OF BISMUTH. T. T. Sugihara, J. Roesmer (Clark Univ., Worcester, Mass.) and J. W. Meadows, Jr. Phys. Rev., 121: 1179-84(Feb. 15, 1961).

An asymmetric mode of mass division in the mass region 66 to 73 was observed in the fission of Bi^{209} with 36-Mev protons. At 58 Mev no evidence for asymmetric fission as a separate mode could be found. The narrowness of the 36-Mev asymmetric peak led to the suggestion that the asymmetric fission of bismuth results from the fission of a single nuclear species and from a closed-shell effect, similar to the fine structure observed in low-energy fission of heavy elements. This asymmetric fission was considered to occur from states of relatively high excitation energy. However, the possibility of asymmetric fission also occurring from states of low excitation energy, whether following neutron evaporation or as a consequence of an inelastic proton interaction, cannot be ruled out. (auth)

12200 LONGITUDINAL POLARIZATION OF O^{14} POSITRONS. J. C. Hopkins, J. B. Gerhart, F. H. Schmidt, and J. E. Stroth (Univ. of Washington, Seattle). Phys. Rev., 121: 1185-9(Feb. 15, 1961).

The longitudinal polarization of positrons from the pure Fermi transition of O^{14} was studied by the method of Bhabha scattering. A prismatic β-ray spectrometer selected 1.0-Mev positrons which then were focused by a solenoidal magnetic lens on a Supermendur foil magnetized by the lens. Scattered positrons and recoil electrons were detected in fast coincidence. The scattering asymmetry observed upon reversal of the lens magnetic field was observed, and the corresponding positron longitudinal polarization calculated. (auth)

12201 NEUTRON TRANSFER TO EXCITED STATES IN N^{15} IN THE REACTION $N^{14}(N^{14},N^{13})N^{15}$. Kenneth S. Toth (Oak Ridge National Lab., Tenn.). Phys. Rev., 121: 1190-2 (Feb. 15, 1961).

The neutron-transfer reaction, $N^{14}(N^{14},N^{13})N^{15}$, was investigated from 6 to 60° c.m. with 28-Mev N^{14} ions accelerated in the Oak Ridge 63-in. cyclotron. Circular strips of aluminum foil, each encompassing a known angular increment, were used to stop the radioactive N^{13}. Excited states in N^{13} are unstable with respect to proton emission; the first excited state in N^{15} was 5.28 Mev above ground. Therefore, N^{13} nuclei resulting from transfers to the ground state of N^{15} are at least 5 Mev more energetic than those resulting from transfers to N^{15} excited states. The two groups of N^{13} particles were distinguished by placing suitable absorbers in front of the aluminum catcher foils. It was found that transfers to excited states become more abundant relative to ground state transfers as the incident N^{14} energy is lowered. (auth)

12202 LIQUID-DROP NUCLEAR MODEL WITH HIGH ANGULAR MOMENTUM. Robert Beringer and W. J. Knox (Yale Univ., New Haven). Phys. Rev., 121: 1195-1200 (Feb. 15, 1961).

The equilibrium shapes of rotating liquid drops were calculated in the spheroidal approximation. The solutions are prolate forms for high angular momenta such as are produced in compound nuclei resulting from heavy-ion bombardments. This is thought to account for the angular and energy distributions observed in heavy-ion-induced fission and light-particle evaporation. (auth)

12203 INTERPRETATION OF THE Fe^{57} ISOMER SHIFT. L. R. Walker, G. K. Wertheim, and V. Jaccarino (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 6: 98-101(Feb. 1, 1961).

A study was made of the Mössbauer effect of Fe^{57} in di- and tri-valent iron compounds and d-group metals. The Hartree-Fock calculations of Watson on the various 3d configurations of iron were combined with the data on the isomeric shifts in the most ionic compounds to calibrate the shift in terms of s-electron density. The difference of the excited and ground state charge radii is calculated to be $\delta R/R = 1.8 \times 10^{-3}$, with the effective radius of the ground state larger than that of the excited state. It is concluded that the ground state is probably not a simple shell state and that a general charge distribution accompanies the isomeric transition. (D.L.C.)

12204 NEW ISOTOPE OF CARBON: C^{16}. S. Hinds (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.), R. Middleton, A. E. Litherland, D. J. Pullen. Phys. Rev. Letters, 6: 113-15(Feb. 1, 1961).

A thin C^{14} target was bombarded with 6-Mev tritons, and the emitted protons were analyzed for evidence of C^{16} formation. An intense proton group was formed which corresponds to the formation of C^{16} in its ground state. The Q value of the $C^{14}(t,p)C^{16}$ reaction was determined to be -3.014 ± 0.016 Mev. An energy-level diagram showing the possible modes of C^{16} decay is presented; the beta decay of C^{16} is expected to be followed by emission of delayed neutrons. Triton bombardments were carried out on targets of Li^7, C^{14}, and O^{18} with a neutron detector, and the delayed neutron intensity decay curves gave half lives of 0.17 ±

0.01, 0.74 ± 0.03, and 4.20 ± 0.08 sec for Li^9, C^{16}, and N^{17}, respectively. The measured mass of C^{16} (16.014702 ± 0.000017 amu) indicates that the first T = 2 state in O^{16} is at ~23.0 Mev. (D.L.C.)

12205 MATRIX ELEMENTS IN THE FORBIDDEN BETA DECAY OF Ce^{141}. D. D. Hoppes (National Bureau of Standards, Washington, D. C. and Catholic Univ. of America, Washington, D. C.), E. Ambler, R. W. Hayward, and R. S. Kaeser. Phys. Rev. Letters, 6: 115-18(Feb. 1, 1961).

The energy and angular distributions of the beta particles from decay of oriented Ce^{141} were measured. These measurements, made with respect to nuclear spin orientation, were used to calculate the contributions of the nuclear matrix elements to the beta transitions. The energy and angular distribution function was determined for the ground-state 580-kev transition. (D.L.C.)

12206 ISOTOPIC SPIN ADMIXTURES IN $Ge^{66} \rightarrow Ga^{66} \rightarrow Zn^{66}$ β TRANSITIONS. W. P. Alford and J. B. French (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 6: 119 (Feb. 1, 1961).

Since the odd-odd nucleus Ga^{66} has zero spin, both the transitions in $Ge^{66} \rightarrow Ga^{66} \rightarrow Zn^{66}$ involve a $\Delta J = 0$ (J = 0) isotopic-spin-forbidden pure Fermi transition. The amplitudes for the beta decay of Ge^{66} and Ga^{66} via admixtures in the ground states are calculated from ft values to be $|\alpha_{21}|^2 \leq 3 \times 10^{-4}$ and $|\alpha_{32}|^2 = 1.4 \times 10^{-5}$. Extension of calculations to $Ga^{64} \rightarrow Zn^{64}$ gives for Ga^{64} $|\alpha_{21}|^2 = 4 \times 10^{-4}$. (D.L.C.)

12207 CAPTURE OF SLOW NEUTRONS BY NUCLEI BOUND IN CRYSTALS. H. E. Jackson, M. L. Bollinger, and R. E. Coté (Argonne National Lab., Ill.). Phys. Rev. Letters, 6: 187-9(Feb. 15, 1961).

The neutron capture cross-section resonance (6.7 ev) of U^{238} was studied in a uranium metal foil and a sample of U_3O_8 in order to detect the predicted effects of recoilless emission and of crystalline binding. The studies were carried out at room, liquid nitrogen, and liquid helium temperatures; and the resonances were compared with both the gas and Debye crystal models. The resonance of the uranium foil at 297°K agrees well with the gas model, whereas that at 4.3°K is displaced toward the lower energies relative to the gas model and agrees better with the Debye model. The resonances of U_3O_8 at 297 and 97°K disagree with both models. (D.L.C.)

12208 ANTISHIELDING OF NUCLEAR ELECTRIC HEXADECAPOLE MOMENTS. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 6: 190-2(Feb. 15, 1961).

It is shown that for ions the nuclear electric hexadecapole moment (HDM) is considerably amplified by antishielding effects similar to those of nuclear quadrupole moments. The antishielding due to nd → d transitions is found to be most intense and may make it possible to observe the HDM in quadrupole resonance spectra of ions in crystals or polar molecules. Shielding effects are also considered. The following nuclei offer good possibilities for observing the HDM: Zn^{65}, Ge^{73}, In^{113}, Sb^{121}, Sb^{123}, and Bi^{209}. (D.L.C.)

12209 PION PRODUCTION BRANCHING RATIOS THROUGH THE 900-MEV RESONANCE. B. A. Munir, E. Pickup, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 6: 192-3(Feb. 15, 1961).

The branching ratio, $r = n_1/n_2$, for the reactions $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ and $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ was measured in a hydrogen bubble chamber for an incident pion energy of 905 ± 2 Mev. It was found to be 1.70 ± 0.17. Values of r from hydrogen bubble chamber data at energies near 900 Mev, determined by various authors, are tabulated and found to give an approximately constant r in the 800- to 1100-Mev energy range. The low results of investigations by Walker et al., obtained in emulsions are discussed. (D.L.C.)

12210 SCATTERING OF PARTICLES ON HEAVY NUCLEI AND THE NUCLEON-NUCLEON CORRELATIONS. J. Dabrowski (Inst. for Nuclear Research, Warsaw). Physica, 26: Suppl., S155-61(Dec. 1960). (In English)

The role of nucleon-nucleon correlations in the optical model for nucleon-nucleus scattering and in the inelastic scattering of electrons on nuclei was investigated. The change introduced into the optical potential was found to be less than 10%. Both the real and imaginary well depths became slightly smaller. An approach to the electron-nucleus scattering problem being worked out by Czyz and Gottfried is outlined. The final results of this work are not yet available. (M.C.G.)

12211 FOUR NUCLEON REACTIONS WITH CENTRAL FORCES. P. G. Burke and W. Laskar (University Coll., London). Proc. Phys. Soc. (London), 77: 49-58(Jan. 1, 1961).

The four-nucleon reaction was formulated using the resonating group method and including the three groupings d-d, n-He^3, and p-t. The central potential used was of Gaussian shape with exchange dependence (Serber and symmetrical exchange were mainly investigated). The wave functions for the nuclear ground states were double Gaussian for deuteron and single Gaussian for t and He^3, the parameter being determined by variational methods to fit the binding energies. Coupled integro-differential equations were derived for each value of the total spin and angular momentum of the corresponding system. Preliminary results obtained by including only one channel for d-d are given. (auth)

12212 EXCITATION OF THE 1s-2p TRANSITION OF ATOMIC HYDROGEN BY PROTON AND ALPHA PARTICLE IMPACT. D. R. Bates (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 77: 59-64(Jan. 1, 1961).

Using the distortion approximation, the cross sections for the collision processes $H(1s) + H^+$ (or He^{2+}) → $H(2p) + H^+$ (or He^{2+}) were evaluated at H^+ energies between 10 kev and $100\sqrt{10}$ kev (or He^{2+} energies between 40 kev and $400\sqrt{10}$ kev). It was found that the effect of distortion is not as much as in the case of $H(1s) + H^+$ (or He^{2+}) → $H(2s) + H^+$ (or He^{2+}). Optically allowed transitions were in general likely to be less influenced by distortion than are optically forbidden transitions. (auth)

12213 PICK-UP REACTIONS ON A ^{9}Be TARGET. F. H. Read and J. M. Calvert (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 77: 65-76(Jan. 1, 1961).

Absolute differential cross sections were measured for the $Be^9(p,d)Be^8(0)$ and $Be^9(p,p)Be^9(0)$ reactions at incident proton energies of 4.85 and 5.49 Mev, and for the $Be^9(d,t)Be^8$ reaction at 5.86 Mev. The pick-up reactions were analyzed in terms of the Butler theory. A comparison of the (p,d) results with those at higher proton energies gave the ranges of validity of the Butler theory and the "transparent-nucleus" Born approximation pick-up theory for the reaction. The neutron reduced width was also deduced from these results. A comparison of the (d,t) results with those at higher deuteron energies showed consistency over a wide energy range. A comparison with the (p,d) reaction gave the triton form-factor $|A_0|^2N_1^2$. Excitation functions were measured for the reaction products of Be^9 + p for bombarding energies between 3.5 and 6.0 Mev and for the reaction

products of Be^9 + d for bombarding energies between 3.8 and 6.3 Mev. (auth)

12214 REDETERMINATION OF THE PANOFSKY RATIO FOR NEGATIVE PIONS STOPPED IN HYDROGEN. D. P. Jones, P. G. Murphy, P. L. O'Neill, and J. R. Wormald (Univ. of Liverpool). Proc. Phys. Soc. (London), 77: 77-80(Jan. 1, 1961).

A lead-glass Cherenkov counter was used as a γ-ray spectrometer to redetermine the Panofsky ratio for negative pions stopped in hydrogen. The ratio was found to be 1.56 ± 0.05. (auth)

12215 THE O^+, T = 1 LEVEL IN ^{18}F. D. Eccleshall and M. J. L. Yates (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Proc. Phys. Soc. (London), 77: 93-6(Jan. 1, 1961).

A search was made for γ rays following the positron decay of Ne^{18} in order to locate the O^+, T = 1 level in F^{18}. Ne^{18} was produced in the reaction $O^{16}(He^3,N)Ne^{18}$. The He^3 beam could be interrupted by a tantalum shutter. Pulse-height spectra obtained during "beam-off" periods showed a γ ray with an energy of about 1 Mev. The possibility of the peak arising from random coincidences between 0.511-Mev annihilation quanta was ruled out. The observed γ ray was identified with a transition from the 1.04-Mev level in F^{18}. It is probable that the level excited is the analog of the ground state of Ne^{18} and has the assignment O^+, T = 1. (M.C.G.)

12216 THE MÖSSBAUER EFFECT IN TIN FROM 120°K TO THE MELTING POINT. A. J. F. Boyle, D. St. P. Bunbury, C. Edwards, and H. E. Hall (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 77: 129-35(Jan. 1, 1961).

Measurements were made of the intensity of the recoilless resonance absorption of the 24-kev γ ray from the decay of Sn^{119m} in metallic tin from 120°K to the melting point. Values of the Debye-Waller factor deduced from these results tended toward the values calculated for a Debye Θ of 142°K at low temperatures; the behavior of the Debye-Waller factor at higher temperatures indicated considerable anharmonicity of the lattice vibrations. Comparison with evidence from the thermal expansion and specific heat suggests that the quartic term in the interatomic potential is positive, and that the ratio of quartic to cubic terms is of the same order as the ratio of cubic to quadratic terms. In the last few degrees below the melting point the resonance absorption showed a rapid drop accompanied by an increase in line width. It is suggested that this effect is due to enhanced self-diffusion in the solid, and it is estimated that the diffusion coefficient reaches a value of 10^{-8} cm^2sec^{-1} about 0.6°K below the melting point. (auth)

12217 FINE STRUCTURE IN THE $^{12}C(\gamma,n)^{11}C$ ACTIVATION CURVE. I. M. Thorson and L. Katz (Univ. of Saskatchechewan, Can.). Proc. Phys. Soc. (London), 77: 166-73(Jan. 1, 1961).

Fine structure in the $C^{12}(\gamma,n)C^{11}$ activation curve was examined in great detail. Eighteen breaks were found between threshold and 23 Mev. The positions of these breaks and the integrated cross sections of the corresponding levels for the (γ,n) reaction are listed. Independent measurements in other laboratories indicated that resonance photon absorption into discrete levels may also be present for the (γ,p) reaction. The failure to observe structure in the (p,γ) inverse reaction thus remains unexplained. (auth)

12218 STRONG COUPLING IN OPTICALLY ALLOWED ATOMIC TRANSITIONS PRODUCED BY ELECTRON IMPACT. M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 77: 174-83(Jan. 1, 1961).

Optically allowed transitions have long-range interaction potentials, behaving asymptotically as s_l/r^1, where s_l is proportional to the dipole matrix element. In calculating cross sections many angular momentum states l must therefore be considered. When the coupling is strong the usual Born approximation leads to violations of conservation conditions which are serious for the smaller values of l. Three variants of the first Born approximation are considered: for the total scattering amplitude, for the reactance matrix, and for the proper phase of the scattering matrix. The second and third approximations satisfy conservation conditions and make some allowance for processes such as $a \rightarrow a' \rightarrow a$, $a \rightarrow a' \rightarrow a''$, and of $a \rightarrow a''$ competing with $a \rightarrow a'$. Considering the case of exact resonance, and replacing the potentials by their asymptotic forms, equations were obtained for which exact analytic solutions may be found. The exact solutions are compared with those obtained using the three approximations. (auth)

12219 THE EVALUATION OF PARTIAL WAVE INTEGRALS IN THE BORN APPROXIMATION. M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 77: 184-91(Jan. 1, 1961).

The Born partial wave integrals may be evaluated by making a harmonic analysis of the integrals occurring in the Born total scattering amplitude. This provides a convenient method for numerical evaluation of the partial-wave integrals. The proofs of an addition theorem for solid harmonics and a multiplication theorem for spherical Bessel functions are included. (auth)

12220 THE CALCULATION OF BORN PARTIAL WAVE INTEGRALS FOR SOME TRANSITIONS IN H PRODUCED BY ELECTRON IMPACT. J. Lawson, W. Lawson, and M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 77: 192-8(Jan. 1, 1961).

Using methods described by Seaton, the partial-wave integrals were calculated for transitions in hydrogen involving the states 1s, 2s, and 2p. (auth)

12221 THE CALCULATION OF ELECTRON-HYDROGEN COLLISION CROSS SECTIONS USING THE BORN APPROXIMATION FOR THE REACTANCE MATRIX. V. M. Burke and M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 77: 199-212(Jan. 1, 1961).

Lawson, Lawson, and Seaton calculated the Born R matrix for H 1s, 2s, and 2p. Using these results the transmission matrix was calculated from $T = -2iR/(I-iR)$. Seaton showed that this should give results which are better than those obtained from the Born approximation for the total scattering amplitude. The following cross sections were calculated: elastic (1s−1s, 2s−2s, and 2p−2p); momentum loss (1s−1s, 2s−2s, 2p−2p, and 2s−2p); inelastic (1s−2s and 1s−2pm_l); and transitions between fine structure levels ($2s_{\frac{1}{2}}-2p_{\frac{1}{2}}$, $2s_{\frac{1}{2}}-2p_{\frac{3}{2}}$, and $2p_{\frac{1}{2}}-2p_{\frac{3}{2}}$). Comparison with experiment showed the results for 1s−2p to be much better than those obtained from the usual Born total amplitude. (auth)

12222 NUCLEAR POTENTIAL IN MANY-BODY PROBLEMS. Jun'ichi Osada (Tokyo Inst. of Tech.) and Minoru Takeda. Progr. Theoret. Phys. (Kyoto), 24: 755-60(Oct. 1960). (In English)

An investigation was made of whether the nuclear potential in the many-body system is the same with that in the two-body system. At first sight it seems that the nuclear potentials are different in these two cases because the momenta of mediating mesons are limited due to the Pauli principle in the case of many-body systems. It was concluded, however, that the energy of a nucleon gas can be calculated correctly by using the T.M.O. potential, which is constructed under the assumption of the existence of only two nucleons, and that extra many-body forces must

not be introduced into the system in addition to the above two-body potential. For simplicity an idealized nucleon gas which interacts with a symmetrical scalar meson field so weakly that the perturbation-theoretic treatment is justified was considered. (auth)

12223 YIELDS OF Cs^{139} AND Ba^{139} IN U^{238} FISSION BY 14 MEV NEUTRONS. I. T. Krisyuk, G. P. Lepnev, and N. B. Platunova. Radiokhimiya, 2: 743-5(1960). (In Russian)

The yield of two isobars in the chain A = 139 where I_{53}^{139} (2.7 sec) → Xe_{54}^{139}(41 sec) → Cs_{55}^{139}(9.5 min) → Ba_{56}^{139}(85 min) La_{57}^{139}(stab) was studied, and a method was developed for determining yields of certain fragments by eliminating active gases in the process of irradiation. The method is verified by a chain with mass number 139. The following yield values were found: Ba^{139}(5.6 ± 1.3)% and Cs^{139}(2.8.6 ± 1.5)%. (R.V.J.)

12224 DETERMINATION OF CERTAIN INDIVIDUAL FRAGMENT YIELDS IN U^{235} FISSION BY 14-MEV NEUTRONS. I. T. Krisyuk, N. B. Platunova, and A. N. Protopopov. Radiokhimiya, 2: 746-8(1960). (In Russian)

The fission yield of Ag^{112}, Cs^{136}, and Nb^{97} is determined and the upper limit for Nb^{96} is evaluated. A method is developed for Cs^{136}, Ag^{112}, and $Nb^{96,97}$ separation from irradiated uranium and the following yields are quoted: Ag^{112} = (5.1 ± 0.6)%, Cs^{136} = (4.0 + 0.5)%, Nb^{97} = (6.9 ± 1.5)%, and Nb^{96} <1%. (R.V.J.)

12225 A SEARCH FOR LONG-LIVED Ca^{50} AND Cr^{56}. William D. Ehmann and John R. Huizenga (Univ. of Kentucky, Lexington). Trans. Kentucky Acad. Sci. 21, Nos. 1-2: 1-5(1960).

Experimental procedures and results of a search for the nuclides Ca^{50} and Cr^{56} are presented. (J.R.D.)

12226 ANGULAR CORRELATIONS IN (d,p) AND (p,d) REACTIONS. G. L. Visotskiĭ (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 289-94(May-June 1960). (In Ukrainian)

Using the distorted wave method the density matrix of colliding particles in the final state was calculated for the case of (d,p) and (p,d) reactions. It was assumed that the particles in the initial state have arbitrary polarization. (auth)

12227 POLARIZATION EFFECTS IN THE SCATTERING OF ELECTRONS ON NUCLEI. A. A. Kresnin and B. I. Tishchenko (Physics and Technical Inst., Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 437-44 (July-Aug. 1960). (In Ukrainian)

Polarization phenomena arising in the scattering of electrons on nuclei with the Yukawa distribution of the charge density are considered in the second Born approximation. The cross sections, the azimuthal asymmetry, and the polarization of the final electrons for the general case of an arbitrary polarized initial beam were determined. (auth)

12228 NUCLEAR RESONANCE ABSORPTION OF γ-QUANTA IN SOLID BODIES WITHOUT RECOIL. Rudol'f L. Mössbauer. Uspekhi Fiz. Nauk, 72: 658-71(Dec. 1960). (In Russian)

A review is given of the method of nuclear resonance absorption of a photon when there is absorption without recoil. The apparatus used for observing these sharp resonance lines at low temperatures is described, and the data for such observations for Re^{187} and Fe^{57} are reported. The shift in absorption for Fe^{57} in a magnetic field is noted as well as the performance of Zn^{67} under similar circumstances. A detailed technique for the preparation of Co^{57} sources is described. Data are reviewed which demonstrates the Doppler effect of the second order, that the width of the absorption resonance conforms with the relative root mean square velocity of the nuclei in the source and absorber. The absorption lines of the 14.4-kev Fe^{57} γ particle when the absorber is a member of Fe_2O_3 and FeS_2 structures are reported. A summary table of the resonance isotopes is given with the energy of the γ particle, the mother isotope, the transition time, the temperature, the line width, and a literature review. (TTT)

12229 THE MÖSSBAUER EFFECT. F. L. Shapiro. Uspekhi Fiz. Nauk, 72: 685-96(Dec. 1960). (In Russian)

A classical theory of the Mössbauer effect is developed which agrees completely with the quantum calculations. A calculation of the quadratic Doppler effect, thermal motion of the nuclei in a lattice, is made and agreement with the width of the isomeric line for Fe^{57} in the Pound and Rebka experiments is obtained. Coherent effects are important only in monoisotopes of substances whose Mössbauer line intensity is close to unity. The effect is also calculated for an admixture and shown to depend on the crystalline and chemical structure. The spectral γ rays of gaseous and liquid sources have a line width of 10^{-3} ev, which is too great in comparison with natural line widths. Mössbauer effects have been investigated for Sn^{119}, which has a width of 2.4×10^{-8} ev for the 23.8-kev γ particle. Magnetic field dependence and intensity as a function of source and absorber relative velocity for Sn and $SnNb_3$ have been measured. Similar measurements on Zn^{67} and Ag^{107} are underway. (TTT)

12230 MEASUREMENT OF THE β-γ CIRCULAR POLARIZATION CORRELATION OF ANTIMONY-124. G. Hartwig (Johannes-Gutenberg-Universität, Mainz). Z. Physik, 161: 221-37(1961). (In German)

In the single forbidden $3^- - 2^+$ beta transition of Sb^{124}, the angular and energy dependence of the β-γ circular polarization correlation was measured. The detection of the circular polarization was made with the help of Compton scattering on polarized electrons in magnetized iron. From these measurements the matrix elements of this transition could be determined by utilization of directional correlation. The evaluation showed that the B_{ij} matrix element contributed. This can be comprehended through the "selection rule effect." (tr-auth)

12231 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUCLIDIC MASSES, McMASTER UNIVERSITY, HAMILTON, SEPTEMBER 12-16, 1960. H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960. 548p. $10.00.

Papers are included which were presented at the International Conference on Nuclidic Masses. The following topics were treated: statistical treatment of data for computation of atomic masses, correlation between masses and properties of nuclei, energy standards for calibration, nuclear reaction energies, beta decay energies, and mass spectroscopy. Separate abstracts have been prepared for 30 of the papers. (D.L.C.)

12232 PRESENT STATUS OF OUR KNOWLEDGE OF NUCLIDIC MASSES. J. Mattauch (Max-Planck-Institut für Chemie, Mainz). p.3-23 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Nuclidic mass data are mainly derived from three classes of observations: total disintegration energies of β decays, total energies released in nuclear reactions, and mass differences of mass spectroscopic doublets. These observations are linear functions of the masses and can be expressed as $y_l = \Sigma_k \kappa_{lk} x_k + \epsilon_l$, where y_l is the re-

sult of the Ith observation, x_k is the kth mass, and ϵ_I is the error of the Ith observation. The least squares method for treating equations of this type is given in detail, and a survey of the recent mass adjustments (in which the whole mass range $1 \leq A \leq 201$ is divided into ten adjustments) is presented. (D.L.C.)

12233 TREATMENT OF INPUT DATA FOR A LEAST SQUARES NUCLIDIC MASS ADJUSTMENT. A. H. Wapstra (Amsterdam and Technical Univ., Delft, Netherlands). p.24-38 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

An adjustment is made on the mass doublet data measured by Nier with errors multiplied by Re/Ri. The reliability of Duckworth's mass doublet data is estimated. The problem of the calibration energy in the determination of nuclear reaction energies is treated. The degree of compatibility of the mass spectroscopic results and the reaction energies is tabulated. (D.L.C.)

12234 MATHEMATICAL DETAILS OF THE MASS COMPUTATION. L. A. König (Max-Planck-Institut für Chemie, Mainz). p.39-57 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A survey is given of the mathematical procedure for the computation of atomic masses in the range of mass number $A \leqq 200$. Because of its large extent the initial problem had to be reduced to simpler problems. The computation could further be simplified by introducing approximations for the masses. Details of the checks of the numerical calculation are mentioned. The procedure for the matrix inversion is outlined briefly. (auth)

12235 THE VALIDITY OF LEAST SQUARES FOR THE ADJUSTMENT OF EXPERIMENTAL DATA. E. Richard Cohen (Atomics International, Canoga Park, Calif.). p.58-81 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A critical examination of the basic formulation of least squares indicates that the invariant properties of the homogeneous quadratic form makes this procedure ideal for the unbiased objective adjustment of experimental data. This invariance property is used to define most of the structure of the method. The difference between grouped and ungrouped experimental equations is considered and it is shown that adjusted values are independent of the procedure used, if the data is appropriately averaged. A Gaussian probability distribution for the experimental errors is introduced and the χ^2 distribution is rigorously deduced for the weighted sum of the residuals. (auth)

12236 THE USE OF NUCLEAR MASS DATA TO INFER PHYSICAL PROPERTIES OF NUCLEI. Alex E. S. Green (Convair, San Diego, Calif.). p.85-93 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A discussion of some physical implications of nuclidic mass data is given. The natural division of discussions into those concerned with gross structure and those with fine structure is illustrated by a plot of mass residuals. An example is given of the use of nuclear mass data to infer physical properties of nuclei. The gross structure of nuclear masses is used in conjunction with other experimental data to infer a generalized mass formula, which contains a linear energy term and a surface symmetry energy. (auth)

12237 EFFECT OF A COMPOSITION DEPENDENT SURFACE TENSION UPON THE MASSES AND STABILITY OF HEAVY NUCLEI. Reinhard Brandt (Univ. of California, Berkeley), Frederick G. Werner, Masami Wakano, Robert Fuller, and John A. Wheeler. p.94-123 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The possibility of a dependence of nuclear surface tension with composition is investigated with respect to stabilization of heavy nuclei against fission. It is concluded that such dependence can have a very great effect on the calculated stability of superheavy nuclei if it exists and has a reasonable order of magnitude, but that its existence cannot be inferred from the mass values and spontaneous fission rates of known nuclei. (D.L.C.)

12238 TOTAL ENERGIES AND OTHER PROPERTIES OF FINITE NUCLEI. K. A. Brueckner (Univ. of California, La Jolla), A. M. Lockett, III, and M. Rotenberg. p.124-49 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The results of a numerical study of the total binding energies and other properties of finite nuclei are presented for O^{16}, Ca^{40}, and Zr^{90}. A qualitative discussion is given of the underlying theory, which is based on the K-matrix theory of the many-body system, and the method of calculation is briefly described. (D.L.C.)

12239 SHELL MODEL INTERPRETATION OF NUCLEAR MASSES. N. Zeldes (Hebrew Univ., Jerusalem). p.150-80 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

An extensive discussion is presented on the shell model interpretation of the experimental trends of nuclear masses. The large-scale behavior of the nuclear mass surface is considered both in the gross and fine details. Experimental data are reviewed for separation energies of various types of nuclei. The four surfaces are summarized by Levy's empirical mass formula, which is then derived theoretically. The deviations of the experimental values from Levy's formula are shown for both heavy and light nuclei. A picture of the nucleus is presented in which particles of the same kind are coupled in saturated pairs as much as possible. Finally, the variation of the nuclear parameters within a given shell region is discussed. The mass formula is expected to become a cubic formula. (D.L.C.)

12240 ALPHA-PARTICLE MEASUREMENTS AND STANDARDS. Frank Asaro (Univ. of California, Berkeley). p.223-7 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The absolute measurement of α-particle energies is discussed with particular reference to Po^{210}. Ra^{224} is suggested as an alternative to Po^{210} as an α source, and a method is given for preparation of thin Ra^{224} sources. Results obtained in modern α-particle spectroscopy are described briefly. (D.L.C.)

12241 ENERGY CALIBRATIONS AND PHOTONEUTRON REACTIONS. Kenneth N. Geller (Univ. of Pennsylvania, Philadelphia). p.228-60 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The present status of betatron energy calibrations is discussed with particular emphasis on the determination

of neutron separation energies from photoneutron threshold measurements. The possible sources of error are examined and possible standards are suggested for establishing a reliable betatron energy scale. A brief description of betatron operation and methods of energy control is given. The photoneutron thresholds were investigated in detail for C^{12}, N^{14}, O^{16}, and F^{19}. The methods used in measuring photoneutron thresholds are outlined, and the errors involved in such measurements are discussed. (D.L.C.)

12242 Q-VALUES FROM CHARGED-PARTICLE REACTIONS. W. W. Buechner (Massachusetts Inst. of Tech., Cambridge). p.263-75 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The current agreement of the Q values for charged-particle reactions with these from mass doublets is discussed. Studies of charged-particle Q values were made with particular emphasis on the nuclei between calcium and copper. The measured Q values for this region were found to agree well with those calculated from the new mass table of Everling et al., but to disagree with those from data collected by Nier with the new mass spectrometer at Minnesota. Some of the results collected at the University of Mexico are described, particularly the $He^3(d,p)$ reaction. (D.L.C.)

12243 Q-VALUES OF NUCLEAR REACTIONS IN THE LIGHT ELEMENT REGION. M. Mazari, R. Domínguez, A. Jáidar, J. Rickards, F. Alba, G. López, and M. E. Ortíz de López (Universidad Nacional Autonoma, Mexico City). p.276-91 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Q values were measured for 48 different reactions among the lighter elements. Spectrograph calibration was done with Po^{210} α particles. The results are compared with those of M.I.T., the weighted averages compiled by Van Potter and Wholing, and the Q values calculated from Everling's mass table. The internal consistency of the measurements was quite good. Masses computed from the Q values are compared with Everling's masses; closer agreement can be obtained if all the measured Q values are lowered by 0.1%. (D.L.C.)

12244 NEUTRON THRESHOLD MEASUREMENTS. T. W. Bonner (Rice Univ., Houston, Tex.). p.292-8 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Neutron threshold measurements can be used to determine reaction Q values, and the accuracy of such measurements is discussed. Work done on thresholds are reviewed for the following reactions: (p,n), (d,n), (α,n), (He^3,n); (H^3,n), (d,2n), and neutrons from heavy ion bombardment. (D.L.C.)

12245 NEUTRON CAPTURE GAMMA RAYS. Henry T. Motz and Robert E. Carter (Los Alamos Scientific Lab., N. Mex.). p.299-316 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

A review of (n,γ) reactions is presented with emphasis on the determination of neutron binding energies by means of capture γ rays. The use of spectrometers in (n,γ) studies is discussed at length with reference to accuracy. Gamma spectra are presented for (n,γ) reactions of N^{14}, Be^9, and Dy. (D.L.C.)

12246 THE DETERMINATION OF BETA DECAY ENERGIES. Leon J. Lidofsky (Columbia Univ., New York). p.319-38 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The problem of assigning statistical weights to various data in the compilation of total β decay energies is considered. The differences techniques for measuring β decay energies are discussed from the standpoint of accuracy. (D.L.C.)

12247 BETA-DECAY-ENERGY SYSTEMATICS, 1960. Katharine Way (National Research Council, Washington, D. C.). p.339-49 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Beta systematics built up by connecting β decay energy points of constant Z with N as abscissa display a large extent of linearity between the major magic numbers. The pattern can be used to predict decay energies by interpolation and extrapolation through one unit with an expected accuracy of ~200 kev. A rule is derived connecting breaks in the pattern with spin changes. (D.L.C.)

12248 ATOMIC MASS DETERMINATIONS IN THE REGION GADOLINIUM TO GOLD. V. B. Bnanot, W. H. Johnson, Jr., and O. A. Nier (Univ. of Minnesota, Minneapolis). p.435-8 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The difficulty of using hydrocarbon molecular or fragment ions as reference masses in mass spectrometric measurement of heavy atomic masses is discussed. Twenty-five doublets and 36 isotopic doublets were measured which, when used with earlier data, enable masses to be computed for over 200 stable and radioactive nuclides in the region from samarium to radon. The results confirm the reported anomalies in the neutron and proton separation energies around 90 and 116 neutrons and show maxima in proton pairing energies around N = 88 and 116. Discontinuities due to shell closures at Z = 82 and N = 126 are also found. (D.L.C.)

12249 NEW DETERMINATIONS OF THE MASSES OF SOME ISOTOPES OF KRYPTON AND XENON. R. R. Ries, R. A. Damerow, and W. H. Johnson, Jr. (Univ. of Minnesota, Minneapolis). p.446-59 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

The peak-matching method was used for the doublet measurements of krypton and xenon isotopes. Results are reported on both the O^{16} and C^{12} mass scales for the following isotopes: Kr^{78}, Kr^{80}, Kr^{82}, Kr^{83}, Kr^{84}, Kr^{86}, Xe^{128}, Xe^{129}, Xe^{130}, Xe^{131}, and Xe^{132}. (D.L.C.)

12250 MASS MEASUREMENT WORK AT OSAKA UNIVERSITY. K. Ogata, H. Matsuda, and S. Matsumoto (Osaka Univ.). p.474-88 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Methods used in the mass measurements made with two mass spectrometers at Osaka Univ. are discussed, and results are reported for the CH_4-O and CH_2-N^{14} doublets and the following mercury and zinc isotopes: Zn^{66}, Zn^{67}, Hg^{198}, Hg^{199}, Hg^{200}, Hg^{201}, and Hg^{202}. A new method of determining mass center position was developed. (D.L.C.)

Particle Accelerators

12251 (AERE-R-3479) VERTICAL FOCUSING AND PHASE SLIP AT THE CENTRE OF AN AVF CYCLOTRON. T. C. Randle (United Kingdom Atomic Energy Authority.

Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 23p.

For an isochronous cyclotron with AVF focusing, vertical stability in the central region is difficult to attain. Magnetic-field laws that maintain vertical focusing by departing from isochronism are calculated; the electric focusing force and also the various starting phases of the ions are taken into account. (auth)

12252 (AFOSR-TN-60-484) THE SPECTROSCOPY OF IONIC COLLISIONS. 1. THE DESIGN AND CONSTRUCTION OF A SIMPLE 100KV PROTON ACCELERATOR. E. M. Reeves (University of Western Ontario, London. Molecular Excitation Group). June 1, 1960. 38p. Contracts AF 19(604)-4560, AF 49(638)-640, and Nonr-2895 (00).

In order to study the luminosity arising from collisions between positive ion beams and atomic or molecular gas targets at 30 to 100 kv, a proton accelerator was constructed. The accelerator employs an Oak Ridge type ion source with an electrostatic focusing system and magnetic mass analyzer to produce a proton ion beam. Technical details of design, construction, accelerator operation, and the operating conditions under which preliminary observations on the spectra resulting from the ionic collisions have been carried out are discussed. (auth)

12253 (AFOSR-TN-60-1480) BEAM OPTICS ANALYSIS USING THE IBM 650. Peter E. Schlein (Johns Hopkins Univ., Baltimore). Nov. 1960. 27p. Contract AF18(603)-143.

An IBM-650 computer program, BOMMIT (Beam Optics Matrix Multiplication and Iteration), is described for facilitation of precision particle beam optics system design. A beam system consisting of an arbitrary ordering, type, and number of optical elements up to a maximum of 50 can be considered. The matrix method is used. (J.R.D.)

12254 (CEA-1548) ÉTUDE DE L'ACCEPTANCE D'UN SYNCHROTRON–A GRADIENT CONSTANT–APPLICATION A SATURNE. (Study of the Acceptance of a Constant Gradient Synchrotron. Application of Saturne). G. Bronca and G. Gendreau (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 47p.

A summary is presented of the work of H. Bell and E. Persico. A detailed analysis is given of the phenomena that occur at the time of injection (collision against the back of the inflector, overshooting of the "useful zone"; collision against the horizontal walls of the chamber) and of capture (assumed to be fast) in a faultless machine. The maximum number of particles that may be injected and captured is determined as a function of various parameters: emittance of the beam injected, radial position of the inflector, synchronous phase or peak HF voltage. A final limitation due to the transverse space charge is then recalled, and conclusions are drawn from the results with particular reference to Saturn. (auth)

12255 (CERN-60-41) WIDE BAND IMPEDANCE MATCHING BY THE ROOT LOCUS METHOD. APPLICATION TO THE DESIGN OF A HIGH POWER RADIOFREQUENCY SYSTEM FOR AN FFAG ACCELERATOR. F. Ferger and A. Susini. (European Organization for Nuclear Research, Geneva.) October 27, 1960. 83p.

One of the principal aims in particle acceleration is to obtain high-intensity beams with a higher duty cycle. Constant-field machines are well suited for this task. Such machines require a wide-band r-f power system. The need of high p.t.t. prevents the use of any mechanical or ferrite type tuning device. Therefore it appears necessary to examine exhaustively the problems of wide-band adaptation of an r-f power amplifier to a resonator. Consideration is given to the 100-Mev FFAG machine whose r-f system consists of two resonators producing an acceleration voltage with constant amplitude equal to a 1500-volt peak between 20 and 30 Mc. The s-plane approach is used throughout since amplitude and phase response become evident at the same time. With the aid of the direct and inverse root-locus method, it is possible to clarify the influence of the various parameters. The main departures from the preceding theory which have been observed in practice are illustrated. (auth)

12256 (CERN-60-43) LES ESSAIS D'ACCELERATION STOCHASTIQUE DANS LE SYNCHRO-CYCLOTRON DE 600 MEV ET LEUR INTERPRETATION. (Analyses of Stochastic Acceleration in the Synchro-cyclotron at 600 Mev and their Interpretation). R. Keller, L. Dick, and M. Fidecaro (European Organization for Nuclear Research, Geneva). Dec. 7, 1960. 29p.

Stochastic acceleration of the beam of the 600-Mev synchrocyclotron was studied. The frequency program for the stochastic acceleration is described, and the acceleration mechanism is determined. Three-dimensional scattering and the constant of vertical scattering are analyzed. Beam loss near the center and in the region $\underline{x}$, where $\underline{r}$ is much larger than $\underline{h}$, is determined. The beam intensity is calculated, and methods to decrease the stochastic focalization are discussed. It is shown that a stochastic acceleration from a zero energy always causes a loss of particles because the focalization forces are too weak in the region where the energy is still very small. If the particles have attained an appreciable fraction of the final energy, the stochastic acceleration does not cause any loss of particles. It is possible to extract a beam from the accelerator in a stochastic method. An electrode placed at maximum energy causes scattering of the beam on both sides of U_{max}, that is, half the beam attains an energy higher than U_{max} and leaves the accelerator and the other half is decelerated and is lost. (J.S.R.)

12257 (DESY-A-2.67) GRUNDSÄTZLICHES ZU UNSEREN WASSER-RÜCKKÜHLANLAGEN. (Fundamentals of the Water Cooling System). (Deutsches Elektronen-Synchrotron, Hamburg). Oct. 24, 1960. 9p.

The basic characteristics for the design of the cooling system were introduced to determine the form which the plant could have. The stepwise construction of the accelerator, with a final energy of 6 Bev (which is to be increased later to 7.5 Bev), is discussed. Changes in the characteristics of the coolant water load, which are not of an essential nature, can still be considered. (tr-auth)

12258 (DESY-A-2.69) SEKUNDÄRE KUHLKREISLAUFE IM RINGTUNNEL. (Secondary Cooling Circuit in the Ring Tunnel). (Deutsches Elektronen-Synchrotron, Hamburg). Nov. 29, 1960. 14p.

By means of illustrations, various possibilities for the conduit of the magnet-coil cooling system are described and discussed. Corrosion, ion exchange, and gas permeability in various conduit materials are described, and the costs of the materials are compared. Plate-type and nest-type heat exchangers are also discussed. (J.S.R.)

12259 (DESY-A-2.70) USE OF GENERALIZED AMPLITUDE AND PHASE FUNCTIONS IN DESIGNING BEAM TRANSPORT SYSTEMS. K. G. Steffen, H. Hultschig, and W. Kern (Deutsches Elektronen-Synchrotron, Hamburg). Aug. 1960. 14p.

The method of amplitude and phase functions used in AG synchrotron theory is generalized for application in high-energy beam transport systems. The beam is represented by phase ellipses, and the ellipse parameters are trans-

formed through the system. A complete description of the beam as a whole, rather than of single-particle trajectories, is thus obtained. The method allows a quick estimate of the cost of a system and appears to be useful in looking for close-to-optimum systems satisfying given experimental requirements. Some suggestions are made concerning the use of an analog computer for treating this problem. (auth)

12260 (DESY-A-2.71) BERECHNUNG DER HOCHFREQUENZRINGLEITUNG. TEIL II. (Calculation of the High Frequency Ring Conduit. Part II). (Deutsches Elektronen-Synchrotron, Hamburg). Dec. 8, 1960. 24p.

The initial amplitude, the relative loss from the ring circuit, and the reflecting factor at the input are calculated for DESY when all acceleration gaps are determined at fixed frequencies. (tr-auth)

12261 (HW-67797) HYDROGEN AND CARBON TARGET PREPARATION FOR A POSITIVE ION ACCELERATOR. R. D. McCormick and J. D. McCormack (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 26, 1960. Contract AT(45-1)-1350. 16p.

A detailed description is given of the techniques used to make hydrogen and carbon targets for a 2-Mev positive ion accelerator. The hydrogen targets were made by adsorbing deuterium or tritium onto titanium or zirconium metals. Two methods, evaporation and sintering, were used for mounting the adsorbing metal on a platinum or tantalum backing disk. Target thickness ranged from 200 to 15,000 $\mu g/cm^2$. Typical atomic ratios of 1 to 1 were obtained. Carbon targets were made by mounting carbon on a platinum backing disk in three ways: evaporation, painting, and cracking. Target thickness ranged from 100 to 5000 $\mu g/cm^2$. (auth)

12262 (JINR-P-486) VLIYANIE SLYCHAINYKH OSHIBOK NA FAZOVOE DVIZHENIE CHASTITS V PROTONNOM LINEINOM USKORITELE. (The Influence of Random Error on the Phase Motion of Particles in a Proton Linear Accelerator). V. N. Zubarev and V. S. Kladnitskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 15p.

An analysis is made of phase motion in a proton linear accelerator when one of the linear accelerating periods is different from the calculated lengths. Moreover, the total number of half-period phase oscillations cannot be fitted along the length of the accelerating system, and the response of the particle energy spectrum at the accelerator outlet is impaired. The influence of high-frequency electric-field resonator intensity variations and variations in particle injection energy is discussed in relation to the theoretical magnitudes of phase motion. (tr-auth)

12263 (MURA-590) A NEUTRINO BEAM DESIGN. Lawrence W. Jones (Midwestern Universities. Research Assn., Madison, Wis.). Aug. 5, 1960. 12p. Contract AT(11-1)-384.

A neutrino beam is designed for use with accelerators such as the MURA FFAG using only quadrupoles. A very feasible system with 25% momentum resolution is described which could produce one neutrino-induced reaction every 10 min in a large hydrogen bubble chamber. (auth)

12264 (SCTM-366-60(14)) SPACE-CHARGE STUDIES. Ralph M. McGehee (Sandia Corp., Albuquerque, N. Mex.). Dec. 12, 1960. 44p.

The results are presented of studies on the effects of space charge on vacuum conduction. One-dimensional models are used for the derivations. Application of results to problems of interest is approximate, but useful orders of magnitude and relative measures of effects are obtained. Several ion accelerator characteristics are discussed. The effects of initial velocity and current density of ions entering an accelerating space are determined for two conditions, fixed electrode spacing and fixed maximum electric field at the accelerating electrode. Multistage acceleration is considered. The influence of contaminating ions on the current density of useful ions is investigated. Current decay after abrupt cutoff of accelerator voltage is determined. (auth)

12265 (AEC-tr-4341) LOSS OF BEAM ON THE PERIPHERAL RADIUS OF A SYNCHROCYCLOTRON (FREQUENCY MODULATED CYCLOTRON). V. P. Dmitrievskiĭ, B. I. Zamolodchikov, and V. V. Kol'ga. A translation of: O Potere Puchka na Predel'nom Radiuse v Fazotrone. Translated by the U. S. Joint Publications Research Service, New York. January 1961. 11p.

The resonance interaction between radial and vertical oscillations in the vicinity of n = 0.25 in large synchrocyclotrons is discussed. Results of analyses indicate that the resonance coupling of the oscillation in this region determines the peripheral radius to which ions can be accelerated in such machines. The transmission of particles through this resonance zone is possible in synchrocyclotrons of small radius since the speed with which the frequency of the oscillation $n \approx 0.25$ changes is much higher. (J.R.D.)

12266 (CEA-tr-R-977) INFLUENCE DES CHAMPS DE FUITE SUR LES OSCILLATIONS BETATRONIQUES DANS UN ACCELERATEUR A AIMANT FENDU. (Effects of Leakage Fields on Betatron Oscillations in an Accelerator with Split Magnets). Jiri Teichman. Translated into French from Czechoslov. J. Phys., 9: No. 1, 47-66(1959). 47p.

A study is made of betatron oscillations in stray fields at the edges of accelerators with a small radius. Two approximations of the configuration of the leak field, chosen on the basis of measurements, are used to establish nonlinear equations for the movement of particles. The transformation matrices for the areas of the leak fields are derived. The case where the equilibrium orbit makes an arbitrary angle with the edge of the magnet is also discussed. (tr-auth)

12267 A PULSED (d,t) NEUTRON SOURCE. A Ádám, L. Bod, Z. Szabó, and L. Szeghő (Central Research Inst. of Physics, Budapest, Hungary). Acta. Phys. Acad. Sci. Hung., 12: 107-18(1960). (In English)

A 200-kv horizontally arranged accelerator was developed and built for the production of neutrons in the $T^3(d,n)He^4$ reaction. Operating and focusing conditions of the apparatus were investigated. A net ion current of 200 to 300 μamp could be focused on the target. The neutron yield as measured from a $Zr-H^3$ target was found to be, for a clean target, 3×10^7 neutrons/μcoulomb. (auth)

12268 LOW COST ELECTRONS FROM NEW, HIGH-POWER ACCELERATORS. POTENTIAL IMPACT ON COMMERCIAL RADIATION-PROCESSING. W. Huber and D. A. Trageser (Stanford Univ., Calif. and High Voltage Engineering Corp., Burlington, Mass.). Atompraxis, 6: 463-9(Dec. 1960). (In English)

The principal features of three types of accelerators, developed for commercial purposes and suitable for energies up to 3 Mev, are outlined. The achieved high-power output is of main economic interest. Many promising fields for the commercial use of high-energy sources of radiation are mentioned and listed. The economic feasibility of wide-

range application of irradiation processing in commercial competition is predicted. (auth)

12269 THE SUPPLY SYSTEM FOR THE MAGNET OF THE PROTON SYNCHROTRON OF THE CERN IN GENEVA. E. H. Ludwig, P. Rauhut, T. Wasserrab, and R. Zwicky. Brown Boveri Rev., 46: No. 6, 327-49(June 1959).

In the 25-Bev proton synchrotron of the CERN in Geneva, the energy required for energizing the magnet is obtained from a mechanical store in the form of rotating masses, to which it is returned when the magnets are de-energized. In accordance with the operating requirements, the magnet current must be raised from zero to 6.4 ka in 1.1 sec and reduced back to zero in 1 sec, during which time the magnet voltage must be kept constant to within ±0.2%. A total of 24 grid-controlled mutators are employed to control this exchange of energy. The peak power of 38.4 Mw is supplied by a turbo-alternator driven by an induction motor. The speed of this motor is governed by an electronically controlled Scherbius set. This new system prevents the load surges from having any repercussions on the supply network, and it provides an average output of about 2.6 Mw, for which the motor is dimensioned. The control equipment for the converter supplying the current is designed in such a manner that the load on the network remains uniform and free of surges and the magnet voltage is kept constant during the build-up of the field. (auth)

12270 THE SCHERBIUS CONTROL SET FOR THE CERN MOTOR-GENERATOR. P. Rauhut. Brown Boveri Rev., 46: No. 6, 350-5(June 1959).

The motor-generator that supplies the power for the CERN proton synchrotron magnet is in principle a synchronous alternator driven by an induction motor. The induction motor is controlled by a Scherbius set having practically no losses, the object being to keep the load on the supply network constant. The function of the Scherbius set and the associated electronic control system which, in this form, represents a completely new venture are described.

12271 THE CONTROL SYSTEM FOR THE CERN MOTOR-GENERATOR SET. K. Rollig. Brown Boveri Rev., 46: No. 6, 356-62(June 1959).

The control system used for the first time with the motor-generator and associated Scherbius set employed for feeding the magnet of the CERN proton synchrotron is described. The effect of the special operating conditions on the nature and speed of control is treated, along with the dynamic response of the cascade and the duties of the various control circuits. (auth)

12272 POWER METERING EQUIPMENT GOVERNING THE MAINS INPUT TO A MOTOR-GENERATOR USED WITH A PROTON-SYNCHROTRON. H. Hödle. Brown Boveri Rev., 46: No. 6, 362-5(June 1959).

The power consumption of the magnet system of the proton synchrotron varies according to the program of work. During operation at constant mains input, a definite desired value must be continuously determined by a power metering system and communicated to the control system in the form of an electrical measurand. The most important control requirements are enumerated in formulas, illustrating the relationship between the quantities governing the control system. (auth)

12273 AN EXTERNAL PROTON BEAM AT THE CERN PROTON SYNCHROTRON. B. Dayton, W. Koch, M. Nikolić, and H. Winzeler (Universität, Bern, Switzerland). Helv. Phys. Acta, 33: 544-6(1960). (In English)

Trajectories of the external beam of the CERN proton synchrotron in the horizontal plane were calculated and show a moderate defocusing. The vertical motion, obtained for three trajectories by graphical piece-wise integration, show positive focusing. These predictions on particle directions were checked on nuclear emulsions placed in arrays at several distances from the target. At 19 m from the target, the observed focal point for the horizontal flux distribution is precisely the calculated value. Vertical profiles of the scattered proton flux at 37 m distance shows the most nearly parallel beam corresponds to a scattering angle of 28 mradians. A target diagram giving the angular distribution in space of scattered 24-Bev protons indicates that half the tracks lie within a space angle of 1 mradian from the average direction. The beam intensity at 90 m from the target is as high as 4000 protons/cm^2 per pulse. (J.S.R.)

12274 EXCITATION OF PARTICLE PHASE OSCILLATIONS IN AN ELECTRON SYNCHROTRON BY MAGNETIC FIELD. FREQUENCY AND INTENSITY OF ACCELERATING FIELD. S. A. Khelfets (Inst. of Physics, The Academy of Sciences, Armenian S.S.R.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 5, 105-13(1959). (In Russian)

Phase oscillations induced by various disturbances were calculated considering adiabatic and radiation damping. The results are expressed as universal single-parameter functions. (R.V.J.)

12275 AN ACHROMATIC SYSTEM OF EXTRACTION FOR PROTON SYNCHROTRONS. R. G. T. Bennett and J. W. Burren (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 14-16 (Jan. 1961).

An achromatic modification of the Piccioni extraction system for weak focusing synchrotrons is described. A quadrupole magnet placed between the target and the extraction magnet is used to cancel the momentum resolution of the extracted beam produced by the synchrotron magnet. The extraction magnet is made radially focusing to give a beam of small dimensions in the exit region. (auth)

12276 ELECTRON LINEAR ACCELERATOR AS A SOURCE OF INTENSE SECONDARY PARTICLE BEAMS. Kazuto Okamoto (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 16: 120(Jan. 1961). (In English)

The possible use of an electron linear accelerator as a source of secondary particle beams is investigated by studying its efficiency for meson (π) production. The accelerator is assumed to give off electrons of energy E_0 = 760 Mev and current I_e = 100 μa, and the gamma equivalent of the electron beam is computed. For a meson (π) converter of beryllium of 2-cm thickness, differential π yields of 6×10^5 π^+/sec and 1×10^6 π^-/sec (T_π = 80 ± 3 Mev) are obtained. If the target has an area of several tens of cm^2, the total yield is $\geq 10^4$ mesons/sec/cm^2, an order of magnitude larger than the π beams from synchrocyclotrons. The problem of the background is briefly considered. It is concluded that an electron linear accelerator should be excellent for generating intense beams of secondary particles. (D.L.C.)

12277 A CONVENIENT METHOD OF CONSTRUCTING ACCELERATOR TUBES. K. R. Chapman and S. Gowariker (Birmingham Univ., Eng.). Nuclear Instr. & Methods, 10: 66-7(Jan. 1961). (In English)

A method for the construction of constant gradient accelerator tubes is described. The advantages of this method are stated, and details are given of the performance of 200-kv tubes. (auth)

12278 PROCEEDINGS OF THE SECOND ACCELERATOR CONFERENCE, AMSTERDAM, OCTOBER 4–6, 1960. Nuclear Instruments & Methods, Volume 11, No. 1, 1961. Amsterdam, North-Holland Publishing Co. 269p.

Papers are presented from the Second Accelerator Conference. They are divided into sections on nuclear physics, particle research, physics research, and radiation research. Separate abstracts have been prepared for each paper. (T.R.H.)

12279 DESIRABLE LINEAR ELECTRON ACCELERATOR CHARACTERISTICS FOR NUCLEAR RESEARCH. L. Katz (Univ. of Saskatchewan, Saskatoon). Nuclear Instr. & Methods, 11: 14-18(Jan. 1961).

A brief discussion is given of the desirable linear electron accelerator characteristics for nuclear research. The various research projects possible with such machines are outlined and the machine characteristics desirable for this research are indicated. (auth).

12280 A DISCUSSION OF COLLIDING BEAM TECHNIQUES. A. Schoch (European Organization for Nuclear Research, Geneva). Nuclear Instr. & Methods, 11: 40-6 (Jan. 1961). (In English)

Colliding beam techniques require ultra-high vaccum and particle currents and densities exceeding substantially those available in present-day accelerators. Accumulation of pulses of accelerated particles in storage devices is commonly considered a way of obtaining the particle numbers necessary. Design proposals for such devices and knowledge on the problems involved are due mainly to groups of the MURA of Princeton University, and to groups in Moscow. The principal difficulties arising are: the limitations to phase space compression imposed by Liouville's theorem, and gas scattering and other statistical effects tending to reduce density and lifetime of beams. In the case of relativistic electrons, orbit radiation helps to overcome these difficulties, and a storage ring system designed for the study of e-e interactions will be tested at Stanford University in the near future. Colliding beam experiments with protons, in conjunction with recently completed Multi-Bev proton synchrotrons, might be feasible if beam stacking can be effected with maximum phase space economy. A low-energy model study planned at CERN is hoped will contribute to answering the question of feasibility. (auth)

12281 THE THREE-STAGE TANDEM ACCELERATOR. P. H. Rose (High Voltage Engineering Corp., Burlington, Mass.). Nuclear Instr. & Methods, 11: 49-62(Jan. 1961). (In English)

The position of this new accelerator among the tools of nuclear physics is yet to be determined. Beam currents of 10 mA and energies as high as 30 Mev will probably be achieved within the next 10 years. The accelerator has all the advantages of constant voltage acceleration. Two forms of the accelerator are described, one with negative ion injection and the other with neutral beam injection. Of the two, neutral beam injection has not only the virtue of having been tried successfully but has the greatest potential for the future. The technical problems associated with the vacuum and ion optics are described and it is pointed out that from an initial 10 mA of positive ions a target current of 191 μA of energetic protons is theoretically possible. Tests with a three-stage tandem accelerator are described which show the various loss mechanisms involved in the accelerator. A small beam of 0.3 mμA was obtained, however, at an energy of 15 Mev and with the excellent energy stability of ±1 in 100,000. Results of experiments in which a neutral helium beam was injected into a tandem accelerator are also mentioned. In conclusion it is shown that neither the vacuum nor the optical problem pose any insoluble problems. Current high vacuum techniques should ensure pressures of 10^{-7} torr in the accelerator. Injection of a converging neutral beam should solve the optical problem, and high currents will eventually be obtained. (auth)

12282 CURRENT EXPERIMENTATION WITH THE TANDEM ACCELERATOR AT THE CHALK RIVER LABORATORIES. H. E. Gove (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Instr. & Methods, 11: 63-92 (Jan. 1961). (In English)

The tandem accelerator began operation at Chalk River in February 1959, and the total fraction of operating time in the 18-month period since then has been about 80%. The installation and major experimental apparatus is described, and a brief summary of the experimental program is given. This is followed by a more detailed description of two aspects of this program. The first concerns the interaction between beams of heavy ions such as C^{12}, N^{14}, and O^{16} with targets of nitrogen, oxygen, fluorine, neon, magnesium, aluminum, and silicon. In this investigation narrow resonance structure was observed in the $C^{12} + C^{12}$ reaction. The second concerns measurements of spins of levels in even-even nuclei lying between O^{16} and Ca^{40}. A particle-in particle-out reaction such as inelastic proton scattering was employed to excite the levels and γ-γ correlations were measured in different geometries. The spins of 18 levels have been assigned to date. (auth)

12283 RECENT RESEARCH IN NUCLEAR REACTIONS USING THE ALDERMASTON TANDEM GENERATOR. K. W. Allen (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Instr. & Methods, 11: 93-111(Jan. 1961). (In English)

The Aldermaston Tandem and 6-Mv electrostatic generators are being used for the study of nuclear reactions produced by protons, deuterons, tritons, and He^3 ions in the bombarding energy range up to 12 Mev. The angular distributions of the emitted charged particles are measured with large magnetic analyzers, which include a multichannel broad-range spectrograph with 24 gaps. The results show that at the higher bombarding energies the reactions proceed predominately by a direct mechanism. Oxygen ions accelerated in the Tandem generator to energies in the range 10 to 40 Mev have been used for Coulomb excitation of energy levels in both rotational and vibrational nuclei and for the measurement of nuclear lifetimes by Doppler shift methods. As a consequence of the large momentum transfer from the incident ions to the target and residual nuclei, Doppler shifts of the emitted γ rays may be up to an order of magnitude greater than in light particle reactions, and the technique is useful for measuring lifetimes in the range 10^{-14} to 10^{-11} sec. Methods of producing ion beams of higher energy by combinations of electrostatic generators are also discussed briefly. (auth)

12284 RECENT ADVANCES IN HIGH POWER MICROWAVE ELECTRON ACCELERATORS FOR PHYSICS RESEARCH. J. C. Nygard (High Voltage Engineering Corp., Burlington, Mass.) and R. F. Post. Nuclear Instr. & Methods, 11: 126-35(Jan. 1961). (In English)

Some large steps forward have been made in the microwave electron linear accelerator art. More power, precision, and versatility than heretofore are now available for use in the search for further fundamental knowledge in nuclear structure. A number of very high current linear accelerators of great precision are described, among which are the following: (1) a 10-Mev synchrotron injector having 200 mA of pulse current with an energy spread of 1% and a divergence of less than 1 milliradian; (2) a 35-

Mev with pulse currents up to 500 mA and 30 μsec pulse length offering 2×10^{12} neutrons per pulse; (3) a very new 130-Mev linear accelerator for the U. S. National Bureau of Standards. A breakthrough in the problem of "beam blow-up" and its possible origin in TM 110 mode excitation is described. New accelerating structures have been employed to advantage in the elimination of this problem. A new and potentially useful r-f power tube called the amplitron is just emerging, and its attractive features are described. Techniques are now available for microwave linear accelerators of arbitrarily great precision and power output. (auth)

12285 THE USE OF VAN DE GRAAFF ACCELERATORS FOR HIGH INTENSITY NEUTRON IRRADIATION OF METALS. U. Gonser and K. Lücke (Technische Hochschule, Aachen). Nuclear Instr. & Methods, 11: 139-43(Jan. 1961). (In English)

In order to study the nature of radiation damage in solids provoked by neutron irradiation, a 3-Mev Van de Graaff accelerator delivering a d^+ beam of 400 mμA was installed. With the help of a beryllium target this apparatus is expected to give a total neutron output of 3×10^{12} neutrons/sec leading to a flux density of about 2×10^{11} neutrons/sec/cm^2 if the specimen is fixed at a distance of 1 cm at the target. This flux density is comparable with that of the reactors in which the more fundamental studies of neutron damage in solids are made. Because of the easier access to the neutron source, an accelerator has many advantages to a reactor, especially if, as it is planned, the experiments will be conducted at liquid helium temperature. This type of experiment, which leads to difficulties inside of a reactor, is of great importance since only then recovery of some of the defects during irradiation can be avoided. Another advantage is that in the case of an accelerator the neutrons are unidirectional and much better monochromatic than in a reactor. (auth)

12286 REACTOR PHYSICS RESEARCH WITH PULSED NEUTRON SOURCES. K. H. Beckurts (Kernforschungszentrum, Karlsruhe, Ger.). Nuclear Instr. & Methods, 11: 144-68(Jan. 1961). (In English)

For the past 6 years pulsed neutron sources have been successfully used for studies of the kinetic behavior of neutrons in matter. Three main fields of interest have been particularly stressed: neutron lifetime measurements in moderators; reactivity measurements on reactor systems; and neutron spectra measurements by time-of-flight techniques. A number of most important results was obtained, particularly in the field of neutron thermalization research. The present status of pulsed source techniques and some of the more relevant results are discussed. (auth)

12287 THE KS–3 MEV VAN DE GRAAFF INJECTOR OF THE FRASCATI ELECTRON SYNCHROTRON. Fernando Amman (Laboratori Nazionali, Frascati, Italy). Nuclear Instr. & Methods, 11: 169-78(Jan. 1961). (In English)

The modifications apported to a standard 3-Mev Van de Graaff, used as injector for the 1100-Mev Frascati synchrotron, are reported. They concern the voltage stabilizer, a compensation circuit that takes care of the fast variations of the voltage at the belt frequency, and the Pierce type electron source. A few data concerning the synchrotron operation in the period Jan. 1 to Aug. 31, 1960, are added. Finally, the project of a storage ring for 250-Mev electrons and positrons, which is being built in Frascati, is described. (auth)

12288 ON ION SOURCES WITH HIGH EFFICIENCY AND INTENSITY. J. Kistemaker (F. O. M. - Laboratorium voor Massaspectrografie, Amsterdam). Nuclear Instr. & Methods, 11: 179-84(Jan. 1961). (In English)

The conditions determining the shape of the ion emitting plasma cap in ion sources are analyzed. Dense plasmas ($n_i = 10^{14}$) give expanding caps like in the Von Ardenne source. Thin plasmas ($n_i = 10^{10}$) give inward bended caps like in all normal ion sources. This difference in shape means a difference in ion emission with a factor ten. The problem of an ion source with a high material efficiency is solved by the magnetic type ion sources. The Von Ardenne source has a high density plasma ($n_i = 10^{14}$) in the emission region with an extremely high electron temperature. Therefore hardly any neutral particles are available. In the magnetic PIG type sources the material efficiency is obtained by internal ion focusing. They run with low plasma density ($n_i = 10^{10}$). For the separation of microgram quantities of rare materials (radioactive or toxic like plutonium) the PIG type source should be preferred over the normally used arc source. (auth)

12289 PHOTOACTIVATION AND PHOTONEUTRON ACTIVATION ANALYSIS. John W. Otvos, V. P. Guinn, H. R. Lukens, Jr., and C. D. Wagner (Shell Development Co., Emeryville, Calif.). Nuclear Instr. & Methods, 11: 187-95(Jan. 1961). (In English)

For the last two years the 3-Mev Van de Graaff electron accelerator at Shell Development Company, Emeryville, California, has been in routine use in neutron activation analysis. Over 30 elements can be analyzed for, some in the parts per million range and some in macro concentrations. The 3-kw electron beam produces bremsstrahlung in a gold target and the photons, in turn, liberate neutrons from a large (15-cm cube) beryllium block immersed in a moderator. The thermal neutron flux available in a volume of over 3 liters is more than 5×10^7 cm^2/sec. Twenty-four samples of 25 ml each can be irradiated simultaneously. The activities produced are measured instrumentally in a scintillation counter using γ-ray spectroscopy. Several activities in the same sample may be distinguished by taking advantage of differences in half life and γ energy. Recently it has been found possible to extend the scope of activation analysis by activating directly with photons. Eighteen metastable isomers of the stable nuclides have been produced, 7 for the first time by direct photoactivation. Bremsstrahlung from the gold target is allowed to act directly on the samples. Although sensitivities are lower, the method is more specific than neutron activation, and in many cases interferences in neutron activation can be eliminated by activating a sample with photons alone. Applications of photoactivation other than chemical analysis are (1) beam energy measurement and (2) dosimetry. (auth)

12290 THE USE OF THE ELECTRON ACCELERATOR IN SOLID STATE PHYSICS. P. Baruch (Laboratoire de Physique de l'Ecole Normale Supérieure, Paris). Nuclear Instr. & Methods, 11: 196-209(Jan. 1961). (In English)

Among the many processes by which electrons in the energy range 300 kev to 3 Mev interact with matter, two are important for the physics of crystalline solids: ionization and nuclear recoils. These processes and their secondary effects are reviewed. Examples are given of their importance. The ionization creates in semiconductors electron-hole pairs in large excess; these extra carriers relax, their recombination laws are studied by various means,

such as "electron-voltaic" effect, excess conductivity decay, emission, and decay of fluorescent light. The nuclear recoils are the cause of radiation damage in most materials. The energy transfer in an electron collision is small, and the incident electron energy has to be greater than a certain threshold to produce permanent displacements, thus creating lattice defects. In electron irradiation these defects are simple point defects (vacancies and interstitials at low temperature, which can combine into simple associations by warming). Electron irradiation can then be used to obtain knowledge of interatomic forces to test the laws of diplacement of atoms by radiation, or to introduce in a crystal point defects in a controllable way. Examples are given such as measurement of threshold in metals and study of lifetime in semiconductors. A curious phenomenon is the failure of the reciprocity law: the magnitude of damage in germanium is dependent not only on the total dose but also on the dose rate. Some emphasis is put on the experimental requirements for electron irradiation of solids: energy and intensity stability, beam steering and controlling, and large range of beam currents, including pulsed operation. The design and mounting of samples are also discussed, specially for low-temperature irradiation. (auth)

12291 HIGH ENERGY RADIATION FOR RESEARCH IN BIOCHEMISTRY AND MICROBIOLOGY. Wolfgang Huber (Stanford Univ., Calif.). Nuclear Instr. & Methods, 11: 210-26(Jan. 1961). (In English)

The applications of accelerators to biological problems were initiated some 30 years ago and have since been increasing at an ever-growing rate. Today they are useful for applications requiring anywhere from a few electron volts to a few billion electron volts. In fact, intense beams of particles of homogeneous composition and uniform Linear Energy Transfer are available only from accelerators, and these are becoming more and more standard tools for chemists and biologists alike. Work during recent years has shown that an understanding of the enormously involved pattern of biochemical radiation effects may be obtained by approaching the subject indirectly through the study of the factors which modify radiation injury. It is this subject of parameters that is discussed to demonstrate the usefulness of high-energy radiation as a research tool in biochemistry and microbiology. The factors that have been recognized to influence the radiation response of biochemical systems include: Linear Energy Transfer, Dose Rate, Composition of Surrounding Medium, Atmosphere (Oxygen Effect), Temperature, and Chemical Modifiers. These parameters can be classified roughly into two general groups; that is, those that are inherent to the radiation itself and those that are extraneous to the radiation but influence the radiation effect. All these parameters are discussed in detail. (auth)

12292 NEUTRON, ELECTRON AND X-RAY BEAMS USED FOR RADIATION RESEARCH FROM A VAN DE GRAAFF GENERATOR. D. Moore (Hammersmith Hospital, London). Nuclear Instr. & Methods, 11: 238-47 (Jan. 1961). (In English)

The Van de Graaff generator of the Medical Research Council at Hammersmith Hospital has been used for radiation research for the past ten years. Details of its special design are given. The accelerator provides neutron, electron, and x radiations up to energies of 2 Mev. High-intensity outputs are possible with beam currents of several hundred microamperes. The conversion from an output of neutrons to an output of x rays is accomplished within a few minutes. Methods of dosimetry are discussed for the delivery of defined doses of either of these radiations for studies in chemical, biological, and pathological research. Examples of the versatility of the accelerator output, together with some of the published work, are included. (auth)

12293 FUTURE ACCELERATORS: INTENSE SOURCES FOR PROCESSING. D. A. Trageser (High Voltage Engineering Corp., Burlington, Mass.). Nuclear Instr. & Methods, 11: 248-53(Jan. 1961). (In English)

Developments are described which will lower the unit cost of radiation power below $1 (U. S.) per kilowatt-hour under a wide variety of design criteria. These criteria are analyzed so that the breadth of design approach can be appreciated. Potential industrial applications indicate the need for electron accelerators in the energy range from below 0.5 to 12 Mev and with beam currents of 1 to 20 mA. Progress on the development of direct accelerators below 3 Mev is noted. An insulating Core Transformer has produced a sustained d-c beam current of 20 mA at 1 Mev. Its adaptation at 0.3 or 0.6 Mev would produce power for less than $10,000 (U. S.) per kilowatt. All the components of the direct accelerator are analyzed in the light of large beam currents. Separation of the accelerator tube from the generator is discussed, and the advantages are cited. The progress in r-f power tubes of linear accelerators is outlined. Tubes for industrial purposes at 15-kw average r-f are now available, while future tubes at ten times the power level are in prospect. Unit capital and operating costs are summarized as a function of power. (auth)

12294 QUANTUM EXCITATION AND RADIATIONAL DAMPING OF ELECTRON OSCILLATION IN CYCLIC ACCELERATORS. F. A. Korolev, O. F. Kulikov, and A. G. Eršov (Moscow State Univ.). Nuovo cimento (10), 18: 1033-6(Dec. 1, 1960). (In English)

A study was made of quantum excitation and radiational damping of betatron oscillations on an S-60 synchrotron of the race-track type. Experimental data were obtained by fast photographic recording of the radiation emitted by the accelerated electrons with subsequent photometrical investigation of the pictures. Formulas are given for the amplitude of the axial and radial oscillations. Analysis was made of the experimental data, and they were compared with theory. In the energy region over 400 Mev, the synchrotron had a pronounced excitation of radial betatron and synchrotron oscillations due to radiation quantum fluctuations. The theory proved to be in satisfactory agreement with experiment but undamped axial oscillations, not predicted by theory, were observed. (M.C.G.)

12295 THE FRASCATI STORAGE RING. C. Bernardini, G. F. Corazza, and G. Ghigo (CNEN, Frascati, Italy). Nuovo cimento (10), 18: 1293-5(Dec. 16, 1960). (In English)

A brief description is given of the Frascati storage ring design for electron-positron colliding beam experiments. Electrons and positrons of 250 Mev each are stored in a d-c weak-focusing magnet. They circulate on the same orbit meeting in the gap of the radio-frequency and in the neighborhood of three other points on the orbit at 90° from each other. The particles are produced by converting the γ rays of the Frascati electron synchrotron on two targets placed inside the acceleration chamber and alternately exposed to the beam. (T.R.H.)

12296 PLASTICS FOR ATOM SMASHERS. James O. Turner (Univ. of California, Berkeley). Rubber & Plastics Age, 41: 1034(1960). (UCRL-8343)

The various uses of plastics in accelerators and associated nuclear physics problems are discussed. These problems involve precise manipulation of pressure, vacuum, voltage, current, magnetic field, and temperature, often with microsecond timing. Plastic scintillators are used heavily, and acrylic plastic has been utilized in the construction of Cerenkov detectors. The electric properties of vinyl chloride–vinyl acetate copolymer and polyvinyl chloride make them suitable for use in high-voltage apparatus. An allyl plastic was used as the retrodirective reflector in a liquid hydrogen bubble chamber. High-strength polyester films have been used for insulation of coils. Laminates of glass fiber and epoxy resin are superior to other materials, and they have been adopted as standard for nonmetallic constructions in the Bevatron vacuum tank. Other uses of epoxy resin are pointed out. (D.L.C.)

12297 SEMIEMPIRICAL METHOD FOR CALCULATING THE ACCELERATING SYSTEM OF A LINEAR PROTON ACCELERATOR WITH A STANDING WAVE. G. Ya. Lyubars'kii, O. M. Nekrashevich, and L. N. Rozentsveig (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 308-18(May-June 1960). (In Ukrainian)

A method for calculating the acceleration obtained in a proton accelerator which uses some data obtained by experimental measurements of the field distribution between the drift tubes is described. (auth)

12298 MEASUREMENT AND STABILIZATION OF THE MAGNETIC FIELD OF A POWERFUL ELECTROMAGNET BY THE METHOD OF NUCLEAR MAGNETIC RESONANCE. M. G. Afans'ev, A. G. Gordienko, L. K. Kolisnichenko, A. P. Williams, and L. I. Sidorenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 319-26(May-June 1960). (In Ukrainian)

A description is given of an installation which makes it possible to measure and stabilize the magnetic field of a 10-kw direct current electromagnet. The range of magnetic field measurements, from 2.5 to 12.5 kilogauss, is covered by means of a single combined pickup operating on proton and lithium nuclear signals. No preliminary electronic stabilization in respect to current is effected. (auth)

12299 ENERGY STANDARDS FOR LOW ENERGY ACCELERATORS. Jerry B. Marion (Univ. of Maryland, College Park and Convair, San Diego, Calif.). p.183-210 of "Proceedings of the International Conference on Nuclidic Masses." H. E. Duckworth, ed. Toronto, University of Toronto Press, 1960.

Several instruments being used for absolute determinations of charged-particle beam energies by either electric or magnetic deflection are listed. Data are examined for five reaction energies which have been most widely measured by these absolute analyzers for calibration purposes; 19 secondary calibration points are also included. The five primary points are: $B^{11}(p,\gamma)$ (resonance); $F^{19}(p,\alpha\gamma)$ (2 resonances); $Al^{27}(p,\gamma)$ (resonance); and $Li^{7}(p,n)$ (threshold). Recommended procedures are given for measuring γ-ray resonance and neutron threshold energies. Two new methods are discussed for calibrating beam energy analyzers for use at high bombarding energies. (D.L.C.)

12300 IMPROVEMENTS RELATING TO IRRADIATION EQUIPMENT. Michael Crowley Crowley-Milling (to Associated Electrical Industries Ltd.). British Patent 860,513. Feb. 8, 1961.

Portable irradiation equipment is designed in which water serves as radiation shielding, eliminating the need of transportation of heavy shielding. The equipment consists of an electron linear accelerator or some other source of intense radiation which can be switched off, water tanks surrounding the source, and a box trailer housing the source. Water is employed for cooling as well as shielding purposes. An electric fence can be erected for more safety around the trailer while the source is being operated. The equipment is suitable for irradiating foods on a conveyer belt, e.g., potatoes. (D.L.C.)

Plasma Physics and Thermonuclear Processes

12301 (AD-239994) PLASMA INTERACTION RESEARCH PROJECT. Final Report No. 4, Covering Period December 1, 1958–November 30, 1959. R. W. Gould and D. G. Dow (California Inst. of Tech., Pasadena. Electron Tube and Microwave Lab.). Contract DA36-039-sc-78230. 29p.

Characteristics of space-charge waves that propagate on a cylindrical plasma column at high frequencies were studied. An exact theory and detailed calculation of the properties of these modes were given in the case of zero and infinite magnetic field for the case of a cold plasma (thermal velocities neglected). The theory of the intermediate magnetic-field case was formulated, but a detailed study of the properties of the modes, which requires machine calculation, was not made. Careful meausurements on a mercury arc discharge plasma column with no magnetic field show that the phase velocity is in agreement with theory and that the attenuation is too large to be accounted for by electron collisions within the column of the plasma. This last condition is probably caused by wall collisions. A small unexplained anomaly in the phase velocity was noted near the electron cyclotron frequency. The plasma traveling wave tube was operated with a static axial magnetic field, and forward wave interaction was obtained. A theoretical and experimental study of the scattering of electromagnetic waves from a plasma column was made to explain anomalous resonances in the reflection coefficient. Careful measurements showed that the major resonance occurs below the plasma frequency and is explained adequately by the simple theories. Other resonances occur in the vicinity of the plasma frequency, and a tentative explanation in which thermal velocities play a significant role was advanced. (auth)

12302 (AD-242179) STUDY OF ELECTROMAGNETIC INTERACTIONS IN PLASMAS. Report No. 1. First Quarterly Progress Report, 1 December 1959 to 30 April 1960. R. W. Gould and D. G. Dow (California Inst. of Tech., Pasadena. Electron Tube and Microwave Lab.). Contract DA36-039 SC-85317. 18p.

A study of the interaction of microwaves with plasmas and electron beam-plasma systems is being conducted. Investigation of the utilization of electron beam-plasma interaction to generate microwave signals (cyclotron orbit oscillator) is described. Construction and initial tests are reported for the first model device for PIG discharge high-density plasma generation. In a study of the resonant modes of a hot cylindrical plasma, the resonances in the scattering cross section were investigated to determine how separation of these depends on column diameter. (J.R.D.)

12303 (AERE-M-736) NECESSARY AND SUFFICIENT CONDITIONS FOR THE HYDROMAGNETIC RAYLEIGH-TAYLOR STABILITY OF A CYLINDRICAL PLASMA. R. J. Tayler (United Kingdom Atomic Energy Authority. Research Establishment, Harwell, Berks, England). Oct. 1960. 14p.

It is shown that conditions for the stability of a cylindrical discharge can be extended to the case in which there is an external gravitational potential present. In particular explicit forms are obtained for the analogues of stability criteria such as the condition for stability of the hard core pinch, Suydam's condition for stability, and the condition for stability against interchange perturbations of a system with a constant pitch magnetic field. (auth)

12304 (AFCRC-TR-60-110) WAVE PROPAGATION IN A PLASMA-CABLE. Technical Final Report October 1, 1957 to September 30, 1959. G. Biener (Munich. Technische Hochschule. Elektrophysikalisches Institut.). 43p. Contract AF61(052)-11. (AD-233778)

For a critical examination of the plasma in a gaseous discharge it is important to know parameters such as density, temperature, collision frequency, and mean free path of the electrons. In the case of moved plasma it is further necessary to know the electronic drift velocity. Electromagnetic waves with propagation characteristics that are affected by the condition of the plasma were used to study time-varying gaseous discharges. The phase difference between two different points of a progressing wave can be determined, and observations on time-varying processes in the gaseous discharge can be made. By these two measuring methods—the wave and the probe method—the plasma parameters at stationary conditions were determined and wave propagation in the plasma cable was further investigated. Experimental works proved that the behavior of the plasma cable itself corresponds to theory. In order to be able to employ the measuring method by phase difference, a progressing wave in the plasma cable not disturbed by terminal reflection is required. By a graphite-cement mixture of a definite proportion inserted into the air space of the cable between the glass wall of the discharge tube and the external metal cylinder, an effective minimum of reflection could be obtained, provided that the absorption path was long enough and the face of the mixture had an exponential shape. (auth)

12305 (AFCRC-TR-60-275) ELECTRON SCREENING IN DENSE DEGENERATE GASES. Final Report. Jack S. Goldstein (Brandeis Univ., Waltham, Mass.). May 30, 1960. 25p. Contract AF19(604)-5563. (AD-242360)

An investigation was made of the screening properties of a degenerate electron gas, with principal attention placed on the physical conditions to be found in white dwarf stars. In particular, the effect on nuclear reaction rates is considered. Although the method of approach differs, the result was found not significantly different from that obtained previously except in a very narrow range of densities. (auth)

12306 (AFCRL-103) THE GAS LAW AND THE CONDUCTIVITY OF A COLLISION-FREE PLASMA. Technical Report No. 104-5. O. Buneman (Stanford Univ., Calif. Electron Devices Lab.). Dec. 12, 1960. Contract AF19(604)-5480. 32p.

The moment method is used to derive a form of two-component magneto-gas dynamics for a collision-free plasma. Closure of the moment equations is achieved by ignoring variations of fourth moments of the peculiar velocities for each component. This provides a "fully adiabatic gas law" which represents a generalization of the single or double adiabatic laws in that it predicts the gyrations of the pressure tensor, as well as the principal pressures. The currents, which small perturbing electric fields cause to flow in each species, are calculated in accordance with its own adiabatic gas dynamics. A conductivity tensor is thus deduced. This tensor is compared with that resulting from rigorous kinetic theory (without closure) for the case of a uniform plasma. It is found to be identical with the "warm plasma approximation" which takes into account temperature to first order. Hence, a two-component fully adiabatic theory describes supersonic phenomena adequately but misses (altogether) the phenomenon of Landau damping. It could serve to provide pessimistic stability tests for nonuniform (confined) plasmas. (auth)

12307 (AFOSR-25) AN OPTICAL ANALOG TO THE MOTION OF MAGNETICALLY TRAPPED PARTICLES. D. Stern (Maryland. Univ., College Park). 1960. Contract AF49(638)-530. 11p.

It is shown that the motion of a beam of light confined in a diamond-shaped mirror geometry has many properties in common with the motion of magnetically confined particles. The significance and reasons of this are discussed; the long-term behavior of the beam's motion is also investigated by means of a simplified model. In this model it is shown that the solution's behavior depends on a certain numerical initial condition and fluctuates according to the terms of its continued fraction development. If this is infinite, the fluctuations will go on indefinitely on a small though not intrinsically limited scale; if on the other hand the numerical value is rational and its expansion finite, the fluctuations will exhibit a recurring pattern which may or may not be superimposed on a monotonous drift. (auth)

12308 (AFOSR-TN-59-1333) MAGNETOHYDRODYNAMIC ACCELERATION OF SLIGHTLY IONIZED, VISCOUSLY CONTAINED GASES. G. Sargent Janes and James A. Fay (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). [1959]. 20p. Contract AF49(638)-659. (AD-241054)

Presented at Second Symposium on Advanced Propulsion Concepts, Oct. 7-8, 1959.

The various physical and aerodynamic factors affecting the design of a steady-flow MHD accelerator having viscous containment and crossed electric and magnetic fields are considered for the case of a slightly ionized gas. These include the effects of tensor electrical conductivity, ion slip, current diffusion, frozen flow and leaving losses, magnetic field and electrode losses, and viscous boundary-layer losses. Some of these effects are also applicable to the case of a completely ionized gas. A particular example portraying most of these effects is presented for the case of a slightly ionized gas. (auth)

12309 (AFOSR-TN-60-1070) AN INVESTIGATION OF THE MACROSCOPIC EQUATIONS FOR A PLASMA. Technical Report No. 13. H. Li and R. D. Mathieu (Pennsylvania State Univ., University Park). May 1960. Contract AF49(638)-647. 35p.

The macroscopic equations for the conservation of mass, momentum, and energy, which are deduced from the particle viewpoint by using the classical Boltzmann equation, are investigated for both a nonreacting and a reacting plasma. The most general form of these equations is presented for variable material constants such as dielectric constant and magnetic permeability. The resulting equations are compared with equations that were obtained from the continuum viewpoint of a control volume and a control surface for the plasma. (auth)

12310 (AFOSR-TN-60-1146) NORMAL-MODE TREATMENT OF PINCH INSTABILITIES. John Sullivan (Northeastern Univ., Boston). May 1960. 80p. Contract AF49(638)555.

The phenomenon of the pinch effect and the most common modes of instability to which it is susceptible are discussed. It was found by mathematical analysis that if the pinch was perturbed radially, the system would be subject to sausage

instabilities, and if perturbed laterally, it could experience kink instability. In the absence of an internal axial magnetic field and exterior conducting surface, the pinch was found to be unstable for all real values of the perturbation wave number. By including an axial magnetic field within the plasma, the system was stabilized against the sausage instability for very small and very large values of the perturbation wave number. With an externally conducting plasma surface, the kink instability is stabilized for small perturbation wave numbers. (M.C.G.)

12311 (AFOSR-TN-60-1412) A HIGH TEMPERATURE TUNNEL USING PLASMA GENERATORS. J. F. Cassidy, F. Martinek, and M. L. Ghai (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Dec. 1960. Contract AF49(638)-243. 46p.

Presented at the Annual American Rocket Society Meetings, Dec. 7, 1960, Washington, D. C.

Experimental investigations carried out during the past two years in developing a high-temperature heat-transfer tunnel using a plasma generator are described. Conventional and continuously operating wind tunnels have been limited to temperatures below 3500°F. The technological development resulting in a wind tunnel capable of continuous operation at temperatures as high as 8000°F is presented. The discharge flow of a gas-stabilized plasma generator was investigated with thermocouple probes and photographic techniques such as schlieren systems, shadowgraphs, and high-speed photography. The results indicated that the flow was unsteady and nonuniform even though plenum chambers and a gas-stabilizing tunnel were used. Advances in arc-generation technology eliminated the objectionable flow characteristics, and satisfactory temperature and velocity profiles were obtained. Development of high-temperature sensing instrumentation was accomplished by advancing the capabilities of refractory thermocouples to a point where only wire calibrations had previously been known. A probe system that will determine the temperature and velocity profiles in a gas stream at temperatures of 5100°F is presented. Various techniques and results derived for calibrating complete probes are presented and discussed. (auth)

12312 (AWRE-NR/P-4/60) HIGH DENSITY PLASMA CONTAINMENT IN THE MAGNETIC BOTTLE. N. J. Phillips (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1960. 21p.

A discussion of the factors which influence the magnetic field in plasmas is presented. Theoretical calculations are included on the effects of instabilities which may act as a mechanism for scattering the current carrying electrons. The effects of reversed magnetic fields in the plasma on containment and heating are also examined. (J.R.D.)

12313 (MATT-29) DISCHARGE CLEAN UP IN THE ETUDE STELLARATOR. M. S. Jones, Jr. and L. G. Smith (Princeton Univ., N. J. Project Matterhorn). March 1960. 55p. Contract AT(30-1)-1238.

A series of experiments performed in the Etude stellarator wherein it was possible to obtain discharges in which the heavy-ion impurity level was of the order of 0.05% of the principal ion constituents is described. Details are given concerning the conditions under which the repetitive bombardment of the discharge tube surfaces by a hydromagnetically unstable plasma produced the low impurity level discharges, the methods by which the impurity level was established, and the resulting changes in other discharge characteristics when the impurity level was lowered. (W.D.M.)

12314 (MATT-Q-12) QUARTERLY REPORT COVERING THE PERIOD JULY 1–SEPTEMBER 30, 1960 [ON PROJECT MATTERHORN]. (Princeton Univ., N. J. Project Matterhorn). October 1960. 37p.

It was established that pumpout starts at the beginning of ohmic heating and persists as long as the field is applied. The confinement time varies linearly with B and with the cross-sectional area of the discharge and is consistent in magnitude with Bohm diffusion. Preliminary results indicate an inverse dependence of τ (diffusion time) on electron temperature. Results using a cylindrical cesium plasma with no applied electric field indicate a diffusion rate consistent with classical (collisional) diffusion in dependence on field ($1/B^2$) and in absolute magnitude. Preliminary results indicate that the effect of curvature in the stellarator U-bends is to enhance rather than diminish the hydromagnetic stability. (For preceding period, see Report Matt-Q-11.) (auth)

12315 (NP-9810) THE STABILITY OF PLASMAS IN THE PRESENCE OF CONDUCTING WALLS. Carl Iddings (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Sept. 9, 1960. 23p. Contract AF04(647)-594. (STL/TR-60-0000-94316)

It has been suggested that the presence of conducting walls can prevent the growth of "flute" instabilities in magnetically confined plasmas. An investigation was made of this possibility in two highly idealized situations. First, the gravitational instability is considered for a fluid that is confined between conducting walls. The magnetic field is taken normal to the conductors. The second problem is the confinement of a plasma column in the angular section between two conducting walls. In this case no gravitational field exists, the magnetic field inside the plasma is zero, and outside the plasma the field is in the φ direction. The first problem is a simple modification of the results of Kruskal and Schwartzchild, and the second is a straightforward boundary perturbation. In both cases unstable solutions exist. (W.L.H.)

12316 (NP-9834) SUMMARY OF SHERWOOD ACTIVITIES. Wendell S. Winn (Defense Atomic Support Agency. Field Command, Albuquerque, N. Mex.). Feb. 1, 1961. 17p.

The progress from Aug. 15, 1960, to Feb. 1, 1961, of the AEC laboratories active in the AEC-controlled thermonuclear research program, the SHERWOOD Project, are reported. The problem areas associated with the development of the principal devices are outlined, and the measures being taken to solve these problems are described. Two large experimental devices that were conceived years ago are in the final states of construction and component testing. These include the Model C Stellarator at Princeton University and the DCX-2 at Oak Ridge National Laboratory. The large Astron facility at Lawrence Radiation Laboratory is in the design and construction stage. A difference of opinion between U. S. scientists and a U.S.S.R. scientist, regarding a particular plasma radiation energy loss, is described as nearing resolution. The problem influenced the final size of a workable fusion reactor. This exchange of theory and computational results indicated that the problem may be one of relatively minor magnitude. Scientific conferences in 1961, where exchange of information relative to controlled thermonuclear reactions is appreciable, are enumerated. (auth)

12317 (RISO-18) INTERNATIONAL SUMMER COURSE IN PLASMA PHYSICS, 1960. (Denmark. Atomenergikommissionen. Forsøgsinstitut, Riso). Nov. 1960. 652p.

Lectures are included on single particle motion, magneto-

hydrodynamics, fundamental equations, stability, relaxation, radiation, thermonuclear aspects, pinch and shock, apparatus concepts, and plasma waves and diagnostics. (J.R.D.)

12318 (UCRL-2931) END LEAKAGE LOSSES FROM THE MIRROR MACHINE. Summary of Remarks made at Sherwood Conference in Berkeley, February 1955. David Judd, William MacDonald, and Marshall Rosenbluth (California. Univ., Berkeley. Radiation Lab.). Mar. 25, 1955. 5p. Contract W-7405-eng-48.

A mathematical analysis is given for the escape of charged ions from the ends of a mirror machine. (W.L.H.)

12319 (USCEC-56-101) RESEARCH ON RAREFIED GASDYNAMICS. Raymond L. Chuan (University of Southern California, Los Angeles. Engineering Center). Nov. 1960. Contract AF18(603)-95. 123p. (AFOSR-22)

A summary is given of the activities and accomplishments on rarefied gas dynamics for the period May 1, 1956, to Sept. 30, 1960. Under the experimental aspect of the program a low-density wind tunnel using a two-phase cycle was developed, as well as a number of associated pressure and density instrumentation devices. Theoretical efforts in solutions of the Boltzmann equation, development of associated boundary conditions, and investigations in magnetohydrodynamics (with special emphasis on the motion of artificial satellites) were also undertaken; the results are summarized. (auth)

12320 (USCEC-83-202) INTERACTION BETWEEN A PLASMA AND A MICROWAVE. Toyoki Koga (University of Southern California, Los Angeles. Engineering Center). Nov. 1960. Contract AF49(638)-831. (AFOSR-3)

A method of investigating the interaction between a plasma and a microwave, which is different from those of the other authors, is proposed. The electric field caused by electrons, the ionization, and recombination are taken into account. The displacement amplitude of electron oscillations is assumed to be small as compared with the wavelength. The number, current, and energy densities (as functions of time) are obtained, together with the damping rate and phase-shift of the microwave. The results are almost exact solutions of the assumed basic equations. In a limiting case, the results agree with those of Margenau. This method will be valid also in cases where magnetic fields are taken into account. (auth)

12321 (USCEC-83-203) A METHOD OF ANALYZING THE BOLTZMANN EQUATION OF ELECTRONS AND ITS APPLICATION TO PLANE OSCILLATIONS OF ELECTRONS IN A WARM PLASMA. Toyoki Koga (University of Southern California, Los Angeles. Engineering Center). Dec. 1960. Contract AF49(638)-831. 26p. (AFOSR-74)

Considering that the mass of an electron is much smaller than that of a heavy particle (ion or molecule) and that the number density of electrons is much smaller than that of heavy particles, the collision term of the Boltzmann equation for electrons is simplified. A method of analyzing the equation is devised by considering the subsidiary equations of the original equation. As an example, a plane oscillation of electrons in a warm plasma is studied. (auth)

12322 (CEA-tr-A-851) POLARISATION DE PLASMA ET INTERACTION DES PARTICULES CHARGEES. (Polarization and Interaction of Charged Particles in Plasmas). G. Ecker and K. G. Muller. Translated into French from Z. Physik 153: 317-30(1958). 24p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 5776.

12323 (NP-tr-542) EQUILIBRIUM CONFIGURATION OF A CONDUCTING FLUID. Shigeo Hamada. Translated by D. Jackson (U.K.A.E.A. Atomic Energy Research Establishment) from Kakuyugō Kenkyu, 11: 542-3(1958). 42p.

An interim analysis is presented of a new formalism relating to the equilibrium of a conducting fluid with infinite electrical conductivity. A method is discussed for solving the equations by successive approximation. A discussion is included of a coordinate system that comprises the current lines, magnetic lines of force, and equi-pressure surfaces; the existence of this system and the constancy of the volume element are shown. The structure of these coordinates is discussed, five theorems are stated, and single-valued coordinates are constructed. The by-products obtained are the deduction that the equi-pressure surface forms a topological torus, the expression for the volume between two equi-pressure surfaces, and the necessary condition for confining the plasma. The condition for the confinement of the plasma that is discussed might be regarded as the formulation of the conventional conception of charge separation from the viewpoint of hydrodynamics. A formalism is presented by means of rewriting the conventional equations of equilibrium in order to explicitly include the plasma shape. At the same time, the existence of proper coordinates is again proved. An illustration is given which shows that various general relations can be deduced. (auth).

12324 WAVE PROPAGATION IN A MOVING PLASMA. F. L. Scarf (Space Tech. Labs., Inc., Los Angeles). Am. J. Phys., 29: 101-7(Feb. 1961).

The electromagnetic properties of a moving plasma are examined in terms of the index of refraction and the Fresnel drag. Simple models are used to illustrate the basic mechanism of electromagnetic propagation and the dependence of the drag coefficient on the parameters of the plasma. (auth)

12325 THE ELECTROMAGNETIC FIELDS OF A DIPOLE IN THE PRESENCE OF A THIN PLASMA SHEET. James R. Wait (National Bureau of Standards, Boulder, Colo.). Appl. Sci. Research, 8B, 397-417(1960). (In English)

The problem of electric and magnetic dipoles located near a thin planar slab or sheet of ionized material was considered. A constant and uniform magnetic field was impressed on the slab. Under the assumption that the thickness of the slab is very small, expressions for the resultant fields were obtained. As a result of the anisotropy of the sheet, it was indicated that the fields are elliptically polarized in general. On carrying out a saddle-point evaluation of the integrals in the formal solution it was found that the far fields may be split into "radiation" and "surface-wave" components. The dependence of the radiation pattern and the surface-wave characteristics on electron density, collision frequency, and the impressed magnetic field is illustrated. (auth)

12326 RAYLEIGH'S PROBLEM IN MAGNETOHYDRODYNAMICS FOR A NON-PERFECT CONDUCTOR. D. G. Drake (Univ. of Liverpool). Appl. Sci. Research, 8B, 467-77(1960). (In English)

The extension of Rayleigh's problem to magnetohydrodynamics is considered for a nonperfect conductor in the presence of a transversely applied magnetic field. The governing equations for the fluid velocity and the electromagnetic quantities were obtained, and the Laplace transform of their solution was found. Results obtained for the particular cases of a perfect conductor and an insulator are compared. The viscous boundary-layer solution and the shearing stress were found, and their dependence on the conductivity of the conductor is discussed. (auth)

12327 HYDROMAGNETIC EQUILIBRIA. Donat G. Wentzel (Univ. of Chicago). Astrophys. J., 5: Suppl. Ser., No. 47, 187-232(Dec. 1960).

Configurations of hydromagnetic equilibrium were calculated in detail, using a variational method that is suitable for an incompressible and infinitely conducting fluid with axisymmetric internal magnetic fields and motions. The shape of the boundary of the fluid, as well as the magnetic and the velocity fields, may be evaluated in terms of a set of integrals of the motion, even when the magnetic and the kinetic energies are comparable to the gravitational potential energy of the fluid. The shape of the boundary is determined by a balance between magnetic forces exerted on the boundary and magnetic and other forces acting on the body of the fluid. If a magnetic field is force-free there necessarily exist magnetic forces acting at its boundary, and the field is stable (even in a compressible medium) only if these forces are balanced by means of other magnetic fields or by nonmagnetic forces. If the fluid is in equilibrium under its own gravitation, one may assume that its boundary is an oblate spheroid. Its eccentricity may be determined by the variational principle. In one configuration, in which a poloidal magnetic field prevails with a strength such that its energy is only 5% of the gravitational potential energy, the ratio of the major to the minor axis of this spheroid is 1.25. This indicates that magnetic stars may be considerably distorted by their magnetic fields. The variational procedure for a fluid rotating as a solid body without magnetic fields results in the well-known Maclaurin spheroids. The interaction of magnetic fields with the rotation is discussed. The virial theorem is an explicit consequence of the variational procedure only if the medium is assumed to be compressible. It is satisfied if the total energy of a configuration is a minimum with respect to the density of the medium. The limiting procedure for an incompressible medium is discussed. (auth)

12328 MILLIMETER WAVE DETERMINATION OF PLASMA ELECTRON DENSITY. Eiichi Yahagi and Eikichi Yamashita. Denki Shikensho Iho, 24: 925-39(1960). (In English)

A microwave interferometer method of determining electron-density profiles in a plasma is outlined, and some experimental results obtained by using 35×10^9 cycle waves are shown for the steady plasma with a d-c discharge tube and also for the transient plasma with pulsed discharge in a Scylla type tube. These experimental results and the method of measurement are discussed. A gaseous discharge plasma is inserted in one arm of a bridge circuit constructed of waveguides and Magic-Tees. The electromagnetic waves from each arm of the bridge are respectively put into the H-branch and E-branch of the receiving Magic-Tee, and the output signals from the crystal detectors at both ends of the rest branches of the Magic-Tee are put into preamplifiers and then into a differential amplifier. Its output signal, which is proportional to sin ϕ, is displayed on a cathode-ray tube, ϕ being the phase angle shifted due to the plasma. Simultaneous observations are made of the interferometer responses and the power level of the electromagnetic wave transmitted through the plasma on a dual-beam synchroscope. The power level of the wave coming from the arm containing the plasma is set sufficiently small compared with that coming from the other arm at the input of the receiving Magic-Tee so that the characteristic indices of the crystals may be free from the level variation of the wave transmitted through the plasma, and the error due to the deviation from the square law and the inequality of the crystal characteristics may be negligible. In this method, therefore, better approximate values for the phase angle shifted through the plasma, whose physical properties may vary rapidly, can be obtained from the observed loci on the cathode-ray tube and a simple equation considering neither the crystal indices nor the set value of the power level ratio between the waves coming from each arm of the bridge. The following results have been obtained by applying the method described to the transient plasmas in the afore-mentioned Scylla-type tube. The electron density increases very rapidly up to a cut-off density (about 1.5×10^{13} electrons/cm^3) within a first few cycles of primary current, and then it may be kept above the cut-off density for about 20 μsec after the primary current disappears. The plasma electron density decays exponentially with a time constant of about 13 μsec during the afterglow. In this experiment the primary current of the discharge tube, which has the first maximum current of about 16 ka, is a damped oscillation with a damping constant of about 3×10^{-2} neper/μsec and with a period of about 8 μsec. (auth)

12329 A PULSE METHOD FOR PROBE MEASUREMENTS IN STATIONARY HIGH CURRENT PLASMA. E. Hayess (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Exptl. Tech. Physik, 8: 145-54(1960). (In German)

An apparatus for the recording of probe characteristics by the pulse method is described. It is especially suitable for high discharge current densities in stationary discharges. With this arrangement measurements are possible by the single-probe and two-probe method. Measurement errors because of impurities or glowing of the probe were avoided by brief operation. (tr-auth)

12330 MEASUREMENTS ON A DUO-PLASMATRON ION SOURCE. P. Huber, C. Poppelbaum, and R. Wagner (Physikalische Anstalt der Universität, Basel, Switzerland). Helv. Phys. Acta, 33: 564-6(1960). (In German)

The cross section of a duo-plasmatron, built according to the plans of C. D. Moak (Rev. Sci. Instr., 30: 694(1959)), is given. The sizes of the total current and the atomic ion current are functions of the arc current in the gas discharge. The curves obtained for the total current as a function of arc current are given for the parameters s (distance between the intermediate electrode and the emission electrode), D (diameter of the intermediate electrode opening), and d (diameter of the emission aperture). It was noticed that the atomic ion fraction was sharply reduced by small s. An adjustable lens system for focusing the beam on a target and a magnet for the analysis of the beam were also built. Examples of the results of the beam analysis are given. (J.S.R.)

12331 CHERENKOV AND TRANSIENT EMISSION OF A CHARGED FILAMENT. G. M. Garibyan and O. S. Margelyian (Eeivan State Univ.). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 5, 91-7 (1959). (In Russian)

A solution was derived for the transient and Cherenkov emission of a current-carrying filament using data for emission in homogeneous media. (R.V.J.)

12332 WAVE INTERACTION IN PLASMA INHOMOGENEITIES. Lewis Wetzel (Brown Univ., Providence). J. Appl. Phys., 32: 327-8(Feb. 1961).

How the perturbation in a homogeneous magnetoplasma may be simply deduced from the phenomenological equations of motion and continuity is shown. This is then compared with the perturbation normally giving rise to second-order wave interaction in a homogeneous plasma. It is

concluded that the local first-order combination currents generated in nonuniform fields may be small or large compared to the second-order currents generated in a uniform region, depending upon the relative size of the gradient of the density to the density itself and the polarization of the primary field with respect to this gradient. (T.R.H.)

12333 DYNAMICAL BEHAVIORS OF PLASMA IN LINEAR PULSE DISCHARGE. Tomio Ariyasu, Yoshiaki Arata, and Minoru Okada. J. At. Energy Soc. Japan, 3: 26-32(1961). (In Japanese)

Dynamical behavior of plasma in linear pulse discharges of nitrogen and argon was observed electrically and optically. At the time of the first pinch of the plasma cylinder, wave forms showed various shapes and values of differentiation of the current with time change from negative to positive values, with an increase of the longitudinal magnetic field ($B_Z = 0 \sim 1{,}150$ gauss). Diameters of plasma at the time of the first pinch were measured from the photographic records taken by a high-speed streak camera. The diameters of the plasma increased and the mean constricting speeds of the plasma cylinder decreased with an increase of the B_Z field. It was assumed that in the case of argon gas discharge strong radiation flashing in a direction perpendicular to the time axis of the monochromatic streak photograph and all over the interior of the discharge tube at the time of the pinch originated from the excited radiation of neutral argon left behind the constricting main plasma. (auth)

12334 ON THE VALIDITY OF TREATING A DENSE PLASMA AS A METAL IN RADIO-FREQUENCY CONTAINMENT OF PLASMAS. F. B. Knox (Inst. of Nuclear Sciences, Lower Hutt, New Zealand). J. Electronics and Control (1), 10: 1-11(Jan. 1961). (In English)

The TM_{100} mode is solved for a cylindrical resonator with plasma and metal walls, the plasma being treated formally as a dielectric. When the polarization electric field is considered explicitly together with the total electric field, the approach of Boot et al. to plasma containment by radiofrequency fields is found to give results for the time-averaged force on a dense plasma which agree with results obtained by treating such a plasma as a metal. Where the electric field terminates in the plasma surface the plasma tends to be dragged out, and where magnetic field is bounded by the surface the plasma tends to be pushed in. (auth)

12335 A METHOD OF MEASURING THE POTENTIAL DISTRIBUTION IN A CYLINDRICAL R. F. CAVITY CONTAINING PLASMA. E. D. Dracott (Services Electronics Research Lab., Baldock, Herts, Eng.). J. Electronics and Control (1), 10: 25-32(Jan. 1961). (In English)

A proposed method of determining the electric potential distribution in a cylinder containing plasma is described. The method consists of shooting an ion beam through the plasma and measuring the position, velocity, and direction of the beam at the points of entry and exit. It is then shown that by varying the input parameters, the potential of a particular point inside the plasma can be computed. Thus the beam can be used to probe all points inside the plasma and the space potential as a function of position obtained. (auth)

12336 EXPERIMENTS ON POWER GENERATION FROM A MOVING PLASMA. H. J. Pain and P. R. Smy (Imperial Coll. of Science and Tech., London). J. Fluid Mech., 10: 51-64(Feb. 1961).

Electrical power of 0.32 Mw was extracted for a period of 100 μsec from a plasma of shock-ionized argon traveling at 4×10^5 cm/sec through a magnetic field of 10,000 G. Currents of more than 10,000 amp were drawn and the resulting modification of the applied field was considered. Maximum power was obtained when the external load was matched to the plasma generator which had an internal impedance equivalent to its own electrical resistance in series with a resistance arising from its behavior as a compressible fluid. Values of the electrical conductivity of the plasma obtained in the experiments (about 3×10^3 mho per meter) showed that the plasma resistance is controlled by electron motion. The values were in good agreement with those found by other methods. (auth)

12337 HYDROMAGNETIC WAVES AND THE TRAPPED RADIATION. PART I. BREAKDOWN OF THE ADIABATIC INVARIANCE. Donat G. Wentzel (National Aeronautics and Space Administration, Washington, D. C.). J. Geophys. Research, 66: 359-62(Feb. 1961).

The magnetic moment of a charged particle traveling through a hydromagnetic wave does not remain constant. The motion through small, static, transverse perturbations of a uniform magnetic field is calculated. The changes of the magnetic moment are not random. They depend strongly on the number of wavelengths traversed by the particle during one Larmor period and on the pitch angle of the gyration. For sinusoidal waves a resonant decrease of the moment may occur when the particle traverses 0.5 wavelength per Larmor period. For sufficiently peaked waves the moment generally decreases if the particle traverses less than about 0.3 wavelength per Larmor period. (auth)

12338 HYDROMAGNETIC WAVES AND THE TRAPPED RADIATION. PART 2. DISPLACEMENTS OF THE MIRROR POINTS. Donat G. Wentzel (National Aeronautics and Space Administration, Washington, D. C.). J. Geophys. Research, 66: 363-9(Feb. 1961).

Theoretical estimates on the nature of hydromagnetic waves in the magnetosphere are reviewed. The calculations of part 1 are applicable near the inner Van Allen belt. The magnetic moment of a fast proton may change significantly in one day. After the mirror point of a proton injected within the belt is raised or lowered by at most a few hundred kilometers, the magnetic moment remains constant. A stationary velocity-dependent distribution of mirror points is established. The existence and finite spatial extent of the inner Van Allen belt are associated with the peak in the hydromagnetic-wave velocity in that region. Results indicate that mirror points of protons above the belt are continuously lowered into the atmosphere. The disappearance of the Argus electrons during a geomagnetic storm is discussed. (auth)

12339 PLASMA CYCLOTRON RADIATION AND FUSION REACTORS. J. D. Jukes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 1-7(Jan. 1961).

The theory of cyclotron radiation from high-temperature plasma confined within a magnetic field was applied to the estimation of the radiation loss from plasma confined in fusion reactors. It is shown how a metallic reflector placed around the plasma should limit the seriousness of this loss. In the case of a mirror machine, comparison was made with the mirror loss and the electrical power dissipated in the coils producing the magnetic field. Ratios of power lost were found as functions of β/η (plasma to magnetic pressure ratio/absorption coefficient of the reflector) and βBR (B is the field strength, R the mean radius) which were also compared with the nuclear yield. For the stabilized pinch and stellarator, cyclotron loss was compared with nuclear yield. With β not less than 0.1, it is shown that cyclotron loss can be unimportant in all three types of D-T reactors. For the D-D mirror machine the minimum necessary value

of BR would be about 2×10^8 gauss cm, whereas, for the pinch or stellarator the minimum necessary current or BR, based only on radiation loss, is 18×10^6 amperes or 3.5×10^6 gauss cm, respectively. (auth)

12340 MEASUREMENTS OF THE PROTON ENERGIES FROM SCEPTRE III. W. M. Jones, K. M. Young, and A. C. L. Barnard (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 8-13(Jan. 1961).

Measurements of the energies of the proton emitted from a deuterium discharge in Sceptre III using nuclear plate cameras gave information on the motions of the fusing deuterons in the discharge. Experimental results on proton energies from four series of exposures at different stabilizing magnetic fields using cameras observing the discharge at nominal angles of 45, 90, and 135° are given, together with the results of exposures of the cameras to monoenergetic protons from the A.E.I. electrostatic generator to find their instrumental linewidths. These results showed that the peaks of the proton spectra observed at 45 and 135° to the discharge axis are due to fusions of deuterons whose center-of-mass velocity along the axis is 5×10^7 cm/sec. The broadening of the proton spectra observed at 90° was due to a center-of-mass motion of the fusing deuterons in the radial plane of about 2×10^7 cm/sec. It also indicated that azimuthal motions occur in this plane. All these motions were largely independent of the stabilizing magnetic field. It was also apparent from the plates that the fusion region of the discharge is displaced from the center of the torus tube at the observation section. (auth)

12341 SYNCHROTRON RADIATION FROM RUNAWAY ELECTRONS IN THE STELLARATOR. R. Motley, C. D. Lustig, and S. Sanders (Princeton Univ., N. J.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 17-21(Jan. 1961). (MATT-43)

The microwave radiation from low-density plasmas following ohmic heating discharges in the B-3 stellarator was studied. The observed spectrum was found to be consistent with a calculated spectrum of synchrotron radiation from runaway electrons accelerated by the applied electric field. The deviation of the radiation frequency from the electron cyclotron frequency was attributed to Doppler shift caused by motion of the emitting electrons along the magnetic field. The maximum observed frequency deviation correspond, within 10%, to the maximum electron velocity which was kinematically possible, over an electron energy range extending from 25 kev to almost 1 Mev. (auth)

12342 EQUILIBRIUM PARTICLE MOTIONS IN PLASMA OF CYLINDRICAL GEOMETRY. P. H. Rebut (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 22-30(Jan. 1961). (In French)

The exact integration of the collisionless Boltzmann equation can be performed by assuming stationary conditions and cylindrical symmetry. With an additional assumption of isotropy on the velocity distribution, it was found that the macroscopic motion is that of a solid body. A relation between the components of the magnetic field was obtained in agreement with experimental results. (auth)

12343 SPECTROSCOPIC OBSERVATIONS OF "FLUCTUATIONS" IN THE SCEPTRE IV DISCHARGE. R. V. Williams (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 31-2 (Jan. 1961).

Attempts were made on Sceptre IV to detect a wave velocity in the fluctuations of spectral line intensity. In a typical pair of oscillograms, a phase displacement was observed between corresponding features. These observations indicated a plasma disturbance which moves round the torus with a velocity of the order of 5×10^6 cm/sec, in the opposite direction to the discharge current. The mean values of the velocities measured from pairs of oscillograms were 5.8×10^6 cm/sec. This phenomenon can be interpreted as being due to a helical instability wave of the type discussed by Ware. (M.C.G.)

12344 RECTIFICATION IN A 50-CYCLE DISCHARGE. P. A. Davenport (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 32-3 (Jan. 1961).

An investigation was made of 50-cycle discharges in which the gas current showed a marked tendency to flow in only one direction with respect to the axial magnetic field. This showed that the discharge behaved as a rectifier, and over a small pressure range centered at 0.5×10^{-3} mm Hg complete rectification occurred. A transverse component of the axial magnetic field caused by the method used to connect the axial field coil system was found to be the cause of the rectification. (M.C.G.)

12345 BIBLIOGRAPHY ON MAGNETO-FLUID-DYNAMICS. J. Nuclear Energy, Pt. C. Plasma Phys.-Accelerators-Thermonuclear Research, 3: 59-92(Jan. 1961).

A bibliography on magneto-fluid-dynamics containing 759 references to material published through 1959 is presented. The topics covered include magnetohydrodynamics, magneto-gas-dynamics, plasma physics, and applications of magneto-fluid-dynamics. (M.C.G.)

12346 A METHOD FOR MEASURING HIGH ELECTRON DENSITIES IN PLASMAS. Susumu Takeda and Michel Roux (Nagoya Univ., Japan and Univ. of Illinois, Urbana). J. Phys. Soc. Japan, 16: 95-8(Jan. 1961). (In English)

It is proposed that high electron densities in plasmas can be determined from the complex reflection coefficient of a plane microwave at the plasma boundary. The coefficient that is related to the electron density and the collision frequency in plasmas is measured from the standing wave pattern produced by the incident and reflected wave at the boundary. As a result of the calculation, for a microwave frequency of 9000 Mc, electron densities of 10^{14} and 10^{16} cm^{-3} are determinable, respectively, from the measurement of 11 and 1.1 degree in the phase angle of the complex reflection coefficient. (auth)

12347 MICROWAVE ATTENUATION BY CYCLOTRON RESONANCE IN A SLIGHTLY IONIZED GAS. Taro Dodo (Hitachi Central Research Lab., Tokyo). J. Phys. Soc. Japan, 16: 293-301(Feb. 1961). (In English)

The Boltzmann equation is solved for the distribution function of electrons in a static uniform magnetic field B_0 and a high-frequency electric field. The tensor of dielectric constant and the propagation constant k are obtained from this solution. The calculations are made by neglecting the square of the amplitude of electric field for two cases $k \parallel B_0$, and $K \perp B_0$. The attenuation spectrum for the second case is not a Lorentzian type, and its maximum occurs at the microwave frequency $\omega \simeq (\omega_c^2 + \omega_p^2 + \nu_m^2)^{1/2}$. If the electron density is high, the attenuation spectrum differs from a Lorentzian type even for the first case. (auth)

12348 SPECTRUM OF THE ELECTRON CYCLOTRON RESONANCE IN A PLASMA. Taro Dodo (Hitachi Central Research Lab., Tokyo). J. Phys. Soc. Japan, 16: 348-9 (Feb. 1961). (In English)

When the electromagnetic wave is propagated through a plasma perpendicular to the static magnetic field, a cyclotron resonance peak should occur at the angular frequency $\omega = (\omega_c^2 + \omega_p^2 + \nu_m^2)^{1/2}$, where $\omega_c/2\pi$, $\omega_p/2\pi$, and ν_m are the gyration frequency $eH/2\pi Mc$, the plasma frequency $(ne^2/m\pi)^{1/2}$, and the collision frequency for momentum transfer, respectively. A microwave attenuation measurement was carried out which verified this relation. It is also remarked that the half widths of the spectra for discharges at 90 and 160 ma are very broad because of the inhomogeneity of the electron density in space. (T.R.H.)

12349 PLASMA OSCILLATIONS. [PART] I. I. B. Bernstein and S. K. Trehan (Princeton Univ., N. J.). Nuclear Fusion, 1: 3-41(1960).

The theory of wave phenomena in plasmas is reviewed. The basic kinetic theory was developed taking into account Coulomb collisions. From this magnetohydrodynamic equations were derived. It is demonstrated that it is legitimate to deal with a closed subset of these equations either in the limit of collision-dominated phenomena or in the limit where the effective phase velocities of the phenomena of interest are much greater than thermal speeds. In case of collision-dominated plasmas the theory of transport coefficients is discussed. These equations were then applied to an extensive treatment of small amplitude wave phenomena in plasmas. A discussion of the dissipative effects on hydromagnetic waves is given. Hydromagnetic waves were also considered from the Chew, Goldberger, and Low theory. Longitudinal and transverse oscillations in current-carrying plasmas are also discussed. Oscillations of a cylindrical plasma are considered, and the phenomenon of ion cyclotron resonance is discussed. The possibility of radiation by plasma oscillations by a uniform sphere is exhibited. Some general results on the stability of longitudinal electron oscillations in nonuniform plasmas are given. A brief treatment of large amplitude electron oscillations is given and the breaking of these oscillations as a dissipative mechanism for the organized plasma motion is discussed. (auth)

12350 RAYLEIGH-TAYLOR INSTABILITIES OF A MAGNETICALLY ACCELERATED PLASMA. T. S. Green and G. B. F. Niblett (Atomic Weapons Research Establishment, Aldermaston, Berks., Eng.). Nuclear Fusion, 1: 42-6(1960). (In English)

High-speed photography was used to study the compression of a deuterium plasma by an axial magnetic field generated by a wide single-turn coil. The inductance of the coil was small compared with that of the external condenser bank so that the plasma imploded at a constant acceleration of 5×10^{12} cm/sec^2. Flutes which developed on the outer surface of the plasma was interpreted as magnetohydrodynamic Rayleigh-Taylor instabilities produced by the inward acceleration of the interface separating magnetic field and plasma. The observed growth rates were in agreement with simple theory. It is shown that the ratio of the diffusivities of magnetic field and momentum determines whether the plasma resistivity or its viscosity is the dominant mechanism for damping the short wavelength instabilities. At the temperature and densities of this experiment the resistivity was primarily responsible for the damping, and the wavelength of "maximum instability" calculated on this basis agreed with the observed value. (auth)

12351 A NECESSARY CONDITION FOR HYDROMAGNETIC STABILITY OF PLASMA WITH AXIAL SYMMETRY. Claude Mercier (Euratom-C.E.A. Fontenay-aux-Roses, Seine, France). Nuclear Fusion, 1: 47-53(1960). (In French)

A necessary condition for plasma stability with a symmetry of revolution is established. It corresponds to localized displacements near surfaces at constant pressure on which the magnetic lines of force are closed. This criterion reduces to that of Suydam for cylindrical symmetry. (tr-auth)

12352 RAPID COMPRESSION HEATING OF A PLASMA IN THE LINEAR Z-PINCH. H. A. B. Bodin, A. A. Newton, and N. J. Peacock (Atomic Weapons Research Establishment, Aldermaston, Berks., Eng.). Nuclear Fusion, 1: 54-61(1960). (In English)

The electrical characteristics of discharges with high and low initial rates of current rise are briefly described. The electrical measurements were used to determine the work done on the plasma by rapid compression. The particle and magnetic energy in the discharge are discussed for both high and low initial rates of current rise (dI/dt (0)) and for discharges with and without an axial magnetic field (H_z). It is shown that the gas is heated much more efficiently both with and without H_z at high dI/dt (0). For dI/dt (0) $\sim 1.5 \cdot 10^{12}$ amp/sec ($H_z = 0$) 15% of the initial bank energy goes into heating the gas and 10% into the magnetic field at the first maximum contraction; for dI/dt $\sim 10^{11}$ amp/sec ($H_z = 0$) 11% goes into the field and only 6.5% into the gas at this time. The energy input to the gas was found to become limited well before peak current, and the initial implosion was not followed by much of the subsequent isentropic compression heating which might be expected, so that the temperature never exceeded about 300 ev; it follows that most of the observed neutron yield ($\sim 10^8$) was not thermonuclear. Data obtained from the electrical waveforms and from high-speed photographs are presented and analyzed, and it is shown that large currents build up outside the central plasma column after the first maximum contraction. Further evidence suggested that these currents flow in wall material boiled off by radiation from the central column. These wall effects accounted for the absence of further isentropic compression heating and also contaminated the central plasma column; they were such as to prevent any significant gain in heating by increasing the power input to the discharge. It was concluded that similar effects probably account for the failure to achieve a thermonuclear temperature in many high-power pinch experiments. (auth)

12353 MAGNETOHYDRODYNAMIC OSCILLATIONS IN CYLINDRICAL CAVITIES. J. Szabo (Univ. of Budapest). Nuovo cimento (10), 18: 811-17(Nov. 16, 1960). (In German)

A cylindrical cavity of arbitrary cross section and length is filled with a barotropic liquid with infinitely large electric conductivity and a negligibly small viscosity. The possible magnetohydrodynamic oscillation shapes were studied for the case where the homogeneous outer magnetic field is parallel to the generators of the cylinder. (T.R.H.)

12354 WAVELENGTH DEPENDENCE OF THE REFRACTIVE INDEX OF A PLASMA IN THE OPTICAL REGION. U. Ascoli-Bartoli, A. De Angelis, and S. Martellucci (C.N.E.N., Rome). Nuovo cimento (10), 18: 1116-37 (Dec. 16, 1960). (In English)

The experiment described is designed to put in evidence the part played by free electrons in the refractivity of noble gas plasmas. The variations in density of the neutral gas and their relation to the degree of ionization are studied. The method of analysis employed is that of optical interferometry. The limits of the sensitivity of this method are also discussed. The plasma was excited by a radiofrequency field. (auth)

12355 THE PLASMA-SHEATH TRANSITION IN A MAGNETIC FIELD. J. E. Allen and F. Magistrelli (C.N.E.N., Rome). Nuovo cimento (10), 18: 1138-47 (Dec. 16, 1960). (In English)

A criterion for sheath formation is presented which allows for the effect of a weak magnetic field. Relevant measurements were made using a low-pressure mercury arc in which an azimuthal or "pinch type" magnetic field could be applied. (auth)

12356 EFFECT OF ELECTRON EXCHANGE ON THE DISPERSION RELATION OF PLASMONS. Oldwig von Roos and Jonas S. Zmuidzinas (California Inst. of Tech., Pasadena). Phys. Rev., 121: 941-2(Feb. 15, 1961).

A calculation of the influence of electron exchange on the dispersion relation of a high-density electron gas at 0°K is described. (auth)

12357 CYCLOTRON RADIATION FROM RELATIVISTIC PARTICLES WITH AN ARBITRARY VELOCITY DISTRIBUTION. Ludwig Oster (Yale Univ., New Haven). Phys. Rev., 121: 961-7(Feb. 15, 1961).

A formula is derived which represents the spectral and angular behavior of cyclotron radiation emitted by a relativistic particle moving in a constant magnetic field and having arbitrary velocity components parallel and perpendicular to the field. This formula is used to describe the emission of an assembly of particles having a Maxwellian distribution function. All broadening mechanisms of practical importance (collisions, relativistic mass variability, and Doppler effects) are included and discussed. (auth)

12358 INTERACTION OF AN ELECTRON BEAM WITH A FULLY IONIZED PLASMA. M. A. Allen and G. S. Kino (Stanford Univ., Calif.). Phys. Rev. Letters, 6: 163-5 (Feb. 15, 1961).

Results are reported of the experiments on amplification of microwave signals on an electron beam by an almost fully ionized thermal cesium plasma. In these experiments, an electron beam is modulated by passing through a helix having a microwave signal, passed through a cesium plasma, detected in a second helix, and collected. The theoretical values of amplification due to electron-plasma interactions were calculated and plotted with the experimental values; the agreement is good in the frequency range ω_c to $\sqrt{\omega_p^2 + \omega_c^2}$, where ω_c and ω_p are the electron cyclotron and plasma frequencies, respectively. (D.L.C.)

12359 AN ERROR IN THE THERMAL CONDUCTIVITY FOR A FULLY IONIZED GAS. R. W. Vaughn-Williams and F. A. Haas (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Rev. Letters, 6: 165-6(Feb. 15, 1961).

The discrepancy between the thermal conductivities for a fully ionized gas perpendicular to the magnetic field calculated by Marshall, and Rosenbluth and Kaufmann is explained on the basis of an error in Marshall's work. This error occurs in Marshall's last collision integral, and the corrected value of a_2^1 gives the same conductivity in the limit of high fields as that of Rosenbluth and Kaufmann, providing their assumption of $m_1 \gg m_e$ is used. (D.L.C.)

12360 GENERATION AND MEASUREMENT OF HIGHLY IONIZED QUIESCENT PLASMAS IN STEADY STATE. R. C. Knechtli and J. Y. Wada (Hughes Research Labs., Malibu, Calif.). Phys. Rev. Letters 6: 215-17(Mar. 1, 1961).

An apparatus is described for generating highly ionized quiescent cesium ion plasmas of useful densities ($\sim 10^{14}$ ions/cm^3) in d-c magnetic fields of 300 to 1500 oersteds. Double-probe methods are found to give correct results and are used to measure the diffusions and profiles of the plasma columns. The volume recombination coefficient is also easily determined and is $<10^{-10}$ cm^3/sec. (T.F.H.)

12361 PLASMA OSCILLATIONS OF ELECTRON GASES. David Pines (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Physica, 26: Suppl., S103-23(Dec. 1960). (In English)

A unifying concept, that of the frequency- and wave number-dependent longitudinal dielectric constant $\epsilon(k,\omega)$, is described which offers a simple way to tie together the theoretical approaches to the electron gas and to describe the plasma oscillations. When $\epsilon(k,\omega) = 0$, it permits the existence of an oscillatory mode with an associated build-up of charge density and electric field potential. The properties of plasmons (quantized plasma waves) were also investigated using the random phase approximation approach. Experimental evidence of plasmons as a well-defined excitation mode in electron systems, which comes from characteristic energy loss experiments in solids, is reviewed. (M.C.G.)

12362 COOPERATIVE INTERACTIONS IN A PLASMA. Kenneth M. Watson (Univ. of California, Berkeley). Physica, 26: Suppl., S188-96(Dec. 1960). (In English)

Aspects of cooperative plasma interactions, with emphasis on nonequilibrium, at high temperature and low density are discussed. Under the conditions assumed, particle collisions played a negligible role. A description of plasma hydrodynamics based on turbulent scattering of electrons and ions is presented. The effect of streaming instability on the initial excitation of plasma waves is also discussed. It was concluded that the interactions between collective plasma excitations may provide the significant mechanisms for irreversible phenomena. (M.C.G.)

12363 ON THE CONSERVATION OF VORTICITY IN MULTI-COMPONENT MAGNETIC HYDRODYNAMICS. N. V. Saltanov. Priklad. Mat. i Mekhan., 24: 1123(Nov.-Dec. 1960). (In Russian)

For a multi-component ideal plasma, an equation was derived for the vorticity of each component (partial vorticity), defined in analogy with the vorticity in ordinary hydrodynamics. The plasma considered must be either a cold, incompressible, or barotropic medium. The lines of the partial vorticity vector (analogous to magnetic flux lines) were found to be "attached" to the particles comprising the given component; there was conservation of the flux of the partial vorticity across an arbitrary material surface constituted of particles of the given component; and there was conservation of the circulation vector along an arbitrary closed contour similarly constituted. Nonconservation of partial vorticity might arise from viscous forces or interparticle collisions. (TTT)

12364 SINGULAR HYPERSURFACES OF ORDER ONE IN RELATIVISTIC MAGNETO-FLUID-DYNAMICS. G. L. Saini (Indian Inst. of Tech., Kharagpur). Proc. Roy. Soc. (London) A, 260: 61-78(Feb. 7, 1961).

In the 4-space of general relativity, there may exist 3 spaces (hypersurfaces), say Σ_3, such as 'weak' shock waves, across which the first derivatives of the various physical quantities may be discontinuous, but these quantities themselves are continuous. An analysis is developed for the study of such singular regions when the matter distribution in space-time is an inviscid, infinitely electrically conducting, charged, compressible fluid. In particular, certain relations are derived which are quite characteristic of a typical Σ_3. With the help of these characteristic relations, it is possible to study the various modes of propagation of weak shock waves in relativistic magnetofluid dynamics. For instance, it is shown that, other than those Σ_3 which

are at rest with respect to the fluid, there exist three types of waves. The requirement that the speeds of these waves be less than that of light restricts the constitution of the fluid. It is also observed that, in the null-field case, there are only two types of waves which have a nonzero speed with respect to the fluid, one of these being purely hydrodynamical, i.e., the sound wave. A formula for the speed of sound in a relativistic gas is derived. Further, the explicit form of the jump conditions for the first derivatives of the physical quantities across an arbitrary Σ_3 are obtained, and the usefulness of the various results is indicated. Finally, some particular cases of the general theory are considered in brief. (auth)

12365 THE FRICTION AND DIFFUSION COEFFICIENTS OF THE FOKKER-PLANCK EQUATION IN A PLASMA. J. Hubbard (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London) A, 260: 114-26(Feb. 7, 1961).

In a recent paper (Thompson & Hubbard 1960) it was shown how the diffusion coefficients of the Fokker-Planck equation could be calculated in the case of a plasma in thermal equilibrium by a method which included automatically correlation effects and avoided the use of a cut-off procedure. The method is extended to plasmas not in thermal equilibrium, and a calculation of the friction coefficient is given. (auth)

12366 NUCLEAR REACTIONS IN STARS. T. G. Cowling (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), A260: 170-5(Feb. 21, 1961).

Thermonuclear reactions important for the generation of stellar energy during different phases of stellar evolution are discussed. (auth)

12367 FLOW OVER A WAVY WALL IN MAGNETO-GAS-DYNAMICS. PART I. EQUILIBRIUM FLOW. O. P. Bhutani (India Inst. of Tech., Kharagpur). Progr. Theoret. Phys. (Kyoto), 24: 721-33(Oct. 1960). (In English)

The hydromagnetic plane steady flow of an infinitely conducting gas over a thin infinite wave-shaped wall is discussed under the condition that the directions of the flow velocity and magnetic field are in the same plane. When the external magnetic field is parallel to the undisturbed stream, the flow is shown to be current free and irrotational except for some surface currents. For the case of external magnetic field perpendicular to the undisturbed stream, the hydromagnetic effects consist of the waves of electric currents and vorticity extending from the body. The drag was determined both for subsonic and supersonic cases. (auth)

12368 REMARKS ON THE VISCOUS DISSIPATION IN RELATIVISTIC HYDRODYNAMICS. Minoru Hamaguchi (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 908-9 (Oct. 1960). (In English)

The order estimation of viscous terms in the derivation of the equation of motion in hydrodynamic processes from the 4-divergence of the covariant energy-momentum tensor is discussed. It was found that the energy dependence of velocity is stronger than that of the viscous coefficient even if the viscous coefficient depends on the temperature. (M.C.G.)

12369 GAPS IN A RAREFIED PLASMA IN THE CHEW, GOLDBERGER AND LOW APPROXIMATION. L. D. Pichakhchi (Khar'kov State Univ.). Ukrain. Fiz. Zhur., 5: 450-7(July-Aug. 1960). (In Ukrainian)

Gap flows in a rarefied plasma on the basis of the magnetohydrodynamic equations of Chew, Goldberger, and Low are discussed. A classification of gaps is presented. Formulas were obtained connecting the jumps in the values describing the gap between them, as well as for the velocities of gap distribution. (auth)

12370 INVESTIGATION OF THE HARD γ-RAY RADIATION FROM THE TOROIDAL DEVICE "TOKAMAK-2." V. V. Matveev and A. D. Sokolov. Zhur. Tekh. Fiz., 30: 1145-51(Oct. 1960). (In Russian)

Descriptions are given of a device for recording the energy and time distribution of strong x radiation (over 50 kev) of the toroidal "Tokamak-2" chamber. (tr-auth)

12371 EXPANSION OF THE SPARK CHANNEL IN FLUIDS. Yu. V. Skvortsov, V. S. Komel'kov, and N. M. Kuznetsov. Zhur. Tekh. Fiz., 30: 1165-77(Oct. 1960). (In Russian)

The initial stages of powerful spark expansion in water taking place in current discharge amplitude up to 7.5×10^5 and accelerated velocity up to 2×10^{11} amp/sec are analyzed. The rate of channel boundary expansion, the velocity of shock waves, the spark intensity in the channel, and the discharge current were investigated. The conductivity and current density in discharge channels are evaluated and hydrodynamic calculations are made of the field of compression and velocities behind the shock waves. (tr-auth)

12372 CHERENKOV OSCILLATIONS OF HYDROMAGNETIC AND MAGNETOSOUND WAVES IN THE THINNED ANISOTROPIC PLASMA. N. L. Tsintsadze and A. D. Pataraya (Inst. of Physics, Academy of Sciences, Tbilisi, Georgian SSS). Zhur. Tekh. Fiz., 30: 1178-85(Oct. 1960). (In Russian)

The excitation of hydromagnetic and magneto-sound waves in rarefied anisotropic plasma appearing with a high-velocity current circuit was studied. (tr-auth)

12373 ABOUT NON-STABILITY OF THE LONGITUDINAL OSCILLATIONS IN ELECTRON-ION PLASMA SITUATED IN AN OUTER ELECTRICAL FIELD. L. M. Kovrizhnykh (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz., 30: 1186-92(Oct. 1960). (In Russian)

The instability of electron-ion plasma longitudinal oscillations in the external electrical field was studied for the case of adiabatic parameter variations. The stability criteria and the expression of increment growth are developed. (tr-auth)

12374 MAGNETOHYDRODYNAMIC WAVES OF FINITE AMPLITUDE. N. V. Saltanov and V. S. Tkalich. Zhur. Tekh. Fiz., 30: 1253-5(Oct. 1960). (In Russian)

The system of equations for ideal incompressible conducting liquids is used for developing the equations for magnetohydrodynamic waves of finite amplitude. (R.V.J.)

12375 STATIONARY FLOW ON CONDUCTING FLUID IN A RECTANGULAR CHANNEL IN PRESENCE OF CROSSING MAGNETIC FIELD. Ya. S. Uflyand (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 30: 1256-60 (Oct. 1960). (In Russian)

A mathematical analysis is made of a plane-parallel motion of incompressible viscous conducting fluid in a uniform magnetic field directed perpendicularly to the motion of the fluid. A precise solution is found for the flow of fluid in rectangular channels with channel walls of ideal conductance. (R.V.J.)

12376 PLASMA PHYSICS. H. Alfvén (Royal Institute of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 1-8(1960). (In English)

The general properties of a plasma are discussed according to electron temperature, ambipolar diffusion, and electric double layers. A survey is given of some general aspects of magnetohydrodynamics along with a discussion of some basic and simple phenomena caused by the inter-

action between the electromagnetic and hydrodynamic forces in fluids. (B.O.G.)

12377 MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELDS. S. Lundquist (Royal Institute of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 9-14(1960). (In English)

The general equation for motion of charged particles in electric and magnetic fields is: $(m/q)\,(dv/dt) = E(r,t) + v \times B(r,t)$, where m is the mass of the particle, and $q = Ze/c$ is the charge in electromagnetic units. A number of special cases are reviewed for: I. E = constant and B = 0; II. E = 0 and B = constant; III. E = constant and B = constant; IV. $E = E_0 \exp[jwt]$ and B = constant; V. magnetic fields varying slowly so that $\dot{B}/B \ll \omega_1$; and VI. $B(r) \neq 0$ and E = 0. (B.O.G.)

12378 PARTICLE VIEW COMPARED WITH HYDRODYNAMICS. S. Lundquist (Royal Inst. of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 15-19(1960). (In English)

Simple relations are obtained for average particle motions if a localizing effect exists. This effect is present in hydrodynamics, and is absent in a plasma. A few of the special aspects of this problem are discussed. (B.O.G.)

12379 RUN-AWAY PHENOMENA AND RELAXATION EFFECTS. S. Lundquist (Royal Inst. of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 20-4(1960). (In English)

An evaluation of the Boltzmann equation was made, and an integro-differential equation was obtained which in certain cases may be easier to solve than the original Boltzmann equation. Special applications were discussed for the following problems: The electric current and heat flow in the presence of a weak electric field and small temperature gradient but without magnetic field; the case of a plasma in a magnetic field; resistivity of electrons moving through a plasma under the influence of static electric fields; and plasma diffusion in magnetic fields under density and density-temperature gradients. (B.O.G.)

12380 PLASMA STABILITY. S. Lundquist (Royal Inst. of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 25-33(1960). (In English)

The mathematical treatment of plasma stability by means of the Boltzmann equation is discussed. The magnetohydrodynamic and Chew-Low-Goldberger approximations are reviewed. (C.W.H.)

12381 MERCURY EXPERIMENTS. S. Lundquist (Royal Inst. of Technology, Stockholm, Sweden). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 34-7(1960). (In English)

Proof is given for the conclusion drawn from the equation $E + v \times B = 0$ in that two material points initially situated on the same vector-line of the magnetic field will always be so. An expression is also derived for the change of B connected with an arbitrary displacement of the fluid. Expressions derived for the influencing of a magnetic field by motion and the electrodynamic force on a medium are combined to obtain the condition $BL\,\sigma\sqrt{\mu^1/\rho} \gg 1$. For the case of mercury under normal laboratory conditions, L = 10 cm, B = 1000 gauss, the value of $BL\,\sigma\sqrt{\mu^1/\rho}$ is 10^{-1}. A calculation was made of the velocity-distribution in a magnetic field. For experimental verification of the theories an apparatus was constructed, in which the mercury was pumped in rectangular pipes through a 10^4 gauss magnetic field. Qualitative agreement was found between theory and experiment for laminar flow. The magnetic field was found to influence the transition between laminar and turbulent flow. (B.O.G.)

12382 COLLISION-FREE HYDROMAGNETIC WAVES. J. E. Allen (Università, Rome, Italy). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959). 38-50(1960). (In English)

A discussion is given for the propagation of hydromagnetic waves through a plasma under conditions in which collisions may be neglected. Two directions of propagation are analyzed: (a) along the magnetic lines of force, and (b) across the magnetic lines of force. It is seen that the phenomena differ appreciably for the two cases. (B.O.G.)

12383 LANGMUIR PROBES AND BOUNDARY PHENOMENA. J. E. Allen (Università, Rome, Italy). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959). 51-60(1960). (In English)

The utilization of Langmuir probes in the identification and characterization of plasma boundary conditions is discussed. (C.H.)

12384 MAGNETIC CONFINEMENT AND DIFFERENT MACHINES. J. E. Allen (Università, Rome, Italy). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 61-8(1960). (In English)

A survey is given of the devices and machines used in the magnetic confinement of plasmas. Different approaches to plasma confinement are discussed: (I) The production of an inward force by utilizing the interaction between azimuthal currents (j_θ) and the longitudinal field (H_z); and (II) the production of an inward force by utilizing the interaction between a longitudinal current (j_z) and an azimuthal magnetic field (H_θ). The currents J_θ and j_z are produced by two methods, i.e., (A) the application of an electric field, or (B) the diffusion of charged particles across magnetic lines of force. Then various combinations of approaches I and II with methods A and B are described for infinite cylinders as well as systems of finite size. The principles of the mirror machine, in which partial confinement of particles is obtained, are described. (B.O.G.)

12385 FAST CIRCUITS. J. E. Allen (Università, Rome, Italy). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 69-75(1960). (In English)

A diagram is given of the fundamental circuit used to produce fast-rising magnetic fields. The equations for the voltage and inductance of the components of the circuit are given. Spark gap and multi-sector devices are discussed. (B.O.G.)

12386 THE BOLTZMANN EQUATIONS. H. L. Jordan (Institut für Kernfusion, GFKF, Aachen, Germany). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 76-81(1960). (In English)

The Liouville equation is used to derive an equation for the physical observables described as the averages of the phase functions in Γ-space. The Grad treatment of the Liouville equation for the reduced distribution functions is discussed. A formal derivation is given of the Boltzmann equation for binary collisions. Boltzmann's H-theorem, Maxwell distribution, and equipartition theorem are discussed on the basis of the formal derivation. A Coulomb collision term is obtained under the assumption that the particles undergo many statistically independent small-angle deflections. (B.O.G)

12387 HYDROMAGNETIC SHOCK WAVES. PART I. THEORY. H. L. Jordan (Institut für Kernfusion, GFKF, Aachen, Germany). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 82-9(1960). (In English)

Elementary shock wave theory is reviewed. Effects of the shock transition zone structure on plasma shock heating are discussed. (C.W.H.)

12388 HYDROMAGNETIC SHOCK WAVES. PART II. EXPERIMENTS. H. L. Jordan (Institut für Kernfusion, GFKF, Aachen, Germany). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 90-6(1960). (In English)

Four general types of experimental set-ups are discussed for producing magnetically driven linear shocks: (1) coaxial electrode discharges, (2) T-tubes, (3) electrodeless discharges, and (4) rail sources. The experimental set-ups and results are given for the AVCO experiments in a magnetic annular shock tube. (B.O.G.)

12389 FAST CIRCUIT TECHNIQUES AND EXPERIMENTS WITH FAST MAGNETIC COMPRESSION DEVICES. H. L. Jordan (Institut für Kernfusion, GFKF, Aachen, Germany). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 97-106(1960). (In English)

Special techniques of fast condensers, low inductance switching, and low inductance magnetic circuits have been developed for the production and heating of plasmas to high temperatures by shock waves with large pressure ratios. Special diagnostic techniques are discussed, such as, electrical shielding, magnetic probes, and time resolved optical methods. A description is given of experiments with fast external magnetic field compression devices. (B.O.G.)

12390 COULOMB COLLISIONS AND PLASMA CONDUCTIVITY. R. J. Bickerton (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 107-18 (1960). (In English)

A formalism is given for the angular deflection of a light particle by the Coulomb field of a heavy particle, which applies whether the force between the particles is attractive or repulsive. The long range nature of Coulomb forces and the basic difficulty involved in applying normal kinetic theory to a plasma is emphasized by the relatively slow decrease in the scattering angle as the impact parameter is increased for large impact parameters. An example is given of a calculation of a diffusion coefficient, for the case in which the test particle is an electron and the field particles are positive ions. The physical processes involved in plasma diffusion are demonstrated by considering a simple cylindrically symmetric situation with electrons and ions drifting radially outwards across a magnetic field. A comparison is made of experimental and theoretical results. (B.O.G.)

12391 EXPERIMENTS WITH WAVES IN A PLASMA. R. J. Bickerton (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 119-25(1960). (In English)

Two experiments are described in which hydromagnetic waves are excited in a plasma and measurements are made of their propagation and damping. In the Harwell experiment a toroidal apparatus was used with a magnetic field of 14 kG applied around the torus. Results were obtained in argon, helium, and neon. The Berkeley experiment was carried out in a straight tube, with the advantage that the excitation and propagation are simpler and not confused by effects caused by toroidal geometry. Only results on phase velocity have been reported and these show a linear dependence between the phase velocity and H_{zo}, the steady magnetic field. If H_{zo} is known the plasma density can be determined by measuring the phase velocity of a principal mode, but measuring the damping distance offers some possibilities for plasma diagnostics. (B.O.G.)

12392 PINCH EFFECT. R. J. Bickerton (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 126-144(1960). (In English)

Theoretical analyses of the "pinch effect" are reviewed. Several pinch devices are discussed. (C.W.H.)

12393 STABILITY EXPERIMENTS. R. J. Bickerton (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 145-50(1960). (In English)

These experiments were instigated to study the relative importance of hydromagnetic and electrostatic instabilities. Experiments are being carried out in linear apparatus in which pinched and unpinched (hard core) discharges are studied. Results are given of experiments performed with hydrogen (pinch and unpinch) and argon (pinch), which show the unpinch to be more stable than pinch, in qualitative agreement with theory. In unpinch discharge the instabilities begin near the cathode. (B.O.G.)

12394 PHENOMENA AT PLASMA-SOLID BOUNDARIES. R. S. Pease (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 151-57(1960). (In English)

A review is given of some of the processes that occur when a plasma is in contact with a solid surface. Pulse heating parameters, $\frac{1}{2}(\pi K\rho C_p)^{1/2}$ are tabulated for several materials. Electrical conditions at the boundary are described for sheaths, cathode arc spots, and unipolar arcs. Experimentally it was found that the secondary electron emission coefficient η increases with energy in the low energy region, reaches a broad maximum at 100 to 1000 ev, and decreases slowly with energy. Secondary electron emission data are tabulated for several materials. (B.O.G.)

12395 SPUTTERING OF SOLIDS BY PENETRATING IONS. R. S. Pease (Atomic Energy Research Establishment, Harwell, Berks, England). Rend. Scuola intern. fis. "Enrico Fermi," Corso XIII (1959), 158-65(1960). (In English)

Theoretical considerations are reported for collision processes occurring during sputtering, which provide guidance on the types of collisions, and formulas for estimating ratio values in the higher energy ranges. These formulas are compared with recently published experimental data in the energy range of interest. (B.O.G.)

12396 IMPROVEMENTS RELATING TO THERMONUCLEAR REACTORS. Jiri George Linhart (to British Thomson-Houston Co., Ltd.). British Patent 855,855. Dec. 7, 1960.

An improved thermonuclear reactor is described whereby electric energy may be derived directly without the need for a prime mover. The reactor consists of a reaction chamber surrounded by two or more metal walls spaced apart and positioned so that charged particles from the reaction bombard the walls to leave a small charge with the inner wall and a large charge with the outer wall. Such a reactor design is suitable for fusion reactions induced by magnetic and electric fields, the electric field oscillating with cyclotron resonance. Two embodiments of the reactor are presented, one for direct current and the other for alternating current. (D.L.C.)

12397 IMPROVEMENTS RELATING TO RADIO FREQUENCY APPARATUS FOR HEATING GASES. Jiri George

Linhart (to British Thomson-Houston Co., Ltd.). British Patent 855,856. Dec. 7, 1960.

An apparatus is described for heating gas to effect thermonuclear reactions. The apparatus consists of a cylindrical chamber in which the gas is contained; a static axial magnetic field is provided; and a r-f electromagnetic wave is fed axially into the chamber so that a cyclotron electron resonance movement commences and the positive ions gain energy from collisions with electrons. In this way, the apparatus necessary for heating gas for thermonuclear reactions is reduced in size. (D.L.C.)

12398 IMPROVEMENTS RELATING TO THERMONUCLEAR REACTORS. Jiri George Linhart (to British Thomson-Houston Co., Ltd.). British Patent 855,857. Dec. 7, 1960.

A thermonuclear reactor design scheme is given in which H^3 is automatically generated by the neutrons from the reaction. Liquid lithium is passed in a tube around the reaction chamber, and H^3 is produced: $Li^6 + n \rightarrow t + He^4$. The H^3 is then extracted and used in the reaction itself: $t + d \rightarrow He^4 + n$ or $t + t \rightarrow He^4 + 2n$. (D.L.C.)

12399 IMPROVEMENTS RELATING TO THERMONUCLEAR REACTORS. Jiri George Linhart (to British Thomson-Houston Co., Ltd.). British Patent 855,858. Dec. 7, 1960.

A thermonuclear reactor is designed with a porous lithium blanket surrounding the reaction space. When the reaction is in progress the blanket is bombarded with neutrons, producing H^3 which is then diffused into the reaction space and supplies the reaction with more fuel. (D.L.C.)

12400 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Arthur Watson Aikin (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 855,859. Dec. 7, 1960.

A thermonuclear reactor is described in which liquid lithium is circulated as coolant around the reaction space. H^3 is generated in the lithium by neutrons from the thermonuclear reaction and may be extracted for use in the reaction itself. The lithium may be alloyed with sodium to lower its melting point, or it may contain dissolved lithium deuteride to improve the efficiency of the reaction. (D.L.C.)

12401 IMPROVEMENTS RELATING TO THERMONUCLEAR REACTORS. Arthur Watson Aiken (to Metropolitan-Vickers Electrical Co., Ltd.). British Patent 855,868. Dec. 7, 1960.

A process for producing thermonuclear reactions is given in which the problem of conduction loss is solved. In this process, a gas discharge is induced in a H^3-deuterium mixture in an intense axial magnetic field of at least 10^5 gauss. This magnetic field damps out discharge instabilities. (D.L.C.)

12402 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann (to United Kingdom Atomic Energy Authority). British Patent 860,231. Feb. 1, 1961.

A liner for a gas discharge apparatus, which shields insulating gaps in the torus from radiation produced in the discharge, is described. Also the pulsed-ring discharge is prevented from touching the walls of the containing torus by making the walls thick and electrically conducting so that the eddy currents induced in them by the movement of the discharge channel toward the wall produce forces tending to resist the movement. The liner is mounted so that the axis coincides with the equilibrium discharge axis rather than with the torus axis. Applications in thermonuclear reactors are discussed. (M.C.G.)

12403 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann (to United Kingdom Atomic Energy Authority). British Patent 860,232. Feb. 1, 1961.

An electrically continuous liner for use between a torus and a pulsed ring discharge induced in gas in the torus is described. The liner, made of corrugated material to increase its effective length, is used to prevent the discharge from touching the walls of the torus. The liner is provided with a circumferential conducting means around its small circumference so that when it is energized it produces a magnetic field which opposes the entry of an applied axial magnetic field into the liner. (M.C.G.)

12404 APPARATUS FOR MANIPULATING A PLASMA. (to U. S. Atomic Energy Commission). British Patent 860,840. Feb. 8, 1961.

A pyrotron for confining a plasma is described which consists of an elongated vacuum chamber in which an axially symmetric magnetic field is set up with axially spaced, nodal reflector field regions. This pyrotron is designed for expanding the plasma during a thermonuclear reaction in order to control the reaction. The programming circuitry is also described. (D.L.C.)

12405 NUCLEAR FUSION REACTOR. George Bryan Francis Niblett and Richard Anthony Fitch (To United Kingdom Atomic Energy Authority). British Patent 861,185. Feb. 15, 1961.

An apparatus is described for heating a gas to thermonuclear reaction temperatures by compression. The apparatus comprises a toroidal tube of quartz or some other material of low electric conductivity enclosed in a copper envelope. Means are provided for a build-up of current in the θ direction of rate $>10^{11}$ amp/sec cm and to induce another current in the Z direction before or after the θ current is produced. Using this apparatus, temperatures of $>3 \times 10^4$ °C were achieved in an air discharge. (D.L.C.)

12406 MICROWAVE HORNS AND CIRCUITRY FOR PLASMA MEASUREMENTS. Charles B. Wharton and Andrew L. Gardner. U. S. Patent 2,971,153. Feb. 7, 1961.

A microwave interferometer circuit is designed for measuring the density and temperature of a plasma. The circuit is arranged to observe the phase shift experienced by a swept frequency band of microwaves beamed through the plasma. It then converts the phase shift to a signal for modulating the intensity input of a cathode-ray oscilloscope in proper synchronization with a vertical deflection input signal corresponding to the swept band of microwave frequencies whereby a number of interference fringes are produced on the screen of the oscilloscope. The departure of the fringe patterns from a horizontal line is indicative of plasma density. In addition, the circuit includes provision for displaying plasma noise energy on a second channel of the oscilloscope and with respect to the same time base as the interference fringes displayed on the other channel. The noise signal can be related to plasma temperature.

Shielding

12407 (HW-65572) SHIELDING PROPERTIES OF ORDINARY CONCRETE AS A FUNCTION OF TEMPERATURE. E. G. Peterson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 2, 1960. Contract AT(45-1)-1350. 42p.

The effect of high temperature on neutron attenuation in concrete was determined. The fast neutron attenuation was exponential and could be adequately predicted using re-

moval theory. The calculated removal cross sections agreed with the measured values to within 3%. Tests indicated that even after penetrating 47.5 in. of concrete the thermal and resonance neutron fluxes had not reached equilibrium with the fast neutron flux. Significant changes in neutron flux values were observed after the concrete was baked at 100, 200, and 300°C. A combination of removal and age theories adequately predicted the increase in the fast, resonance, and thermal neutron fluxes. The measured relaxation lengths and removal cross sections are summarized. Changes in reflector and thermal shield thickness or composition from test values would affect the relaxation length. The shield facility was calibrated so that removal cross sections can be measured. The dose rate generated through the full thickness of the as-cured specimens was primarily due to the fast neutrons. After the concrete was baked at 300°C, the dose rate was a result of resonance neutron leakage. The γ dose rate was measured through 47.5 in. in the 100°C test only. The data indicated that the biological dose rate through 47.5 in. of concrete is primarily due to γ leakage at this temperature. (auth)

12408 (NP-9817) DETERMINATION OF PARAMETERS IN AN EMPIRICAL FUNCTION FOR BUILD-UP FACTORS FOR VARIOUS PHOTON ENERGIES. Technical Note N-389. Interim Report. Arthur B. Chilton, Dennis Holoviak, and Lawrence K. Donovan (Naval Civil Engineering Lab., Port Hueneme, Calif.). Aug. 1960. 14p. Project Y-FO11-05-402.

The use of a simple analytical expression for dose build-up factors from a radioactive isotropic point γ source is described. The parameters of the expression were determined by the method of least squares to obtain an optimum fit to experimental data for build-up factors for aluminum at various photon energies. (auth)

12409 (NP-9851(Vol.II)) A MONTE CARLO CALCULATION OF GAMMA RAY PENETRATIONS THROUGH IRON SLABS. M. O. Burrell and D. L. Cribbs (Lockheed Aircraft Corp., Marietta, Ga.). Jan. 1960. 220p. (NR-82 (Vol.II)).

A Monte Carlo sampling is used to calculate the transmitted number and energy current, number and energy flux, and dose of γ rays penetrating an iron slab. The results are presented for 6 thicknesses of iron, 5 source energies, and 5 incident angles. Scattered dose and energy flux transmission factors are determined for 120 equal solid angles. The energy flux transmission factors are divided into four energy groups. A weighted average energy is determined for each solid angle. The total output represents some 25 hr of computing time on the IBM-704. Most of the data have been preserved on IBM cards. (auth)

12410 (CEA-tr-A-793) LE CALCUL DES RÉCIPIENTS À RADIOISOTOPES ÉTANCHES AUX RAYONNEMENTS. (The Estimation of Tightness of Radioisotope Containers for Radiation). Rolf Plesch. Translated into French from Atompraxis 5: 49-53(1959). 18p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 12578.

12411 CONVENTIONAL BUILDING MATERIALS AS PROTECTIVE RADIATION BARRIERS. E. Dale Trout, John P. Kelley, and Arthur C. Lucas (General Electric Co., Milwaukee). Radiology, 76: 237-44(Feb. 1961).

A study was made of the radiation shielding provided by various conventional building materials. An x-ray unit, provided with a diaphragm that could be adjusted for square or rectangular fields, was used as the source. Structural panels of 8 typical wall materials were tested. These panels ranged in thickness from a thin gypsum plaster wall to a thick cinder block and Portland cement mortar wall. Radiographs were made of representative areas of each wall section. The transmission data were converted to lead equivalents and also to concrete equivalents. A schematic sketch is included of a typical radiographic room presenting typical shielding situations. Data are tabulated on the thickness of lead which would have to be added to a particular wall to provide adequate shielding when using the various types of construction. It is concluded that the shielding effect of masonry walls is sufficient to provide useful barriers for many applications. Walls of conventional building materials should be considered in shielding calculations even though they may not provide all the shielding necessary in a given wall. A considerable reduction in the amount of lead required will usually be effected. (C.H.)

12412 CONSIDERATIONS OF SHIELDING FOR CESIUM-137 SOURCES, CONTAINING CESIUM 134. R. A. Beique and M. N. Lougheed (Ontario Cancer Inst., Toronto). Radiology, 76: 281-6(Feb. 1961).

Studies were made of shielding requirements for a 2000-c Cs^{137} source with a maximum additional activity of 5% Cs^{134}. It is pointed out that planning the shielding of a treatment head loaded with Co^{60} pure Cs^{137} involves calculation of the necessary number of half-value layers. The addition of Cs^{134} makes the problem more complex, since the higher three energies of Cs^{134} rely predominantly on density shielding factors rather than photoelectric. Data are tabulated on the γ spectra of Cs^{134} and Cs^{137}. Graphs indicate the relative importance of photoelectric and Compton effects with relation to atomic number and energy, the transmission of γ radiation from Cs^{134}, Cs^{137}, and Co^{60} through concrete and lead, and the increase in output due to the addition of specific percentages of Cs^{134} to Cs^{137} used in γ sources. (C.H.)

12413 A TEST ON PAINT FOR PROTECTION AGAINST STRAY RADIATION. Nobuyoshi Muta and Tadashi Sato (Sapporo Medical Coll.). Sapporo Igaku Zasshi, 17: 148-9(Feb. 1960). (In Japanese)

A paint for protection against stray radiation was tested. The paint in question consists of three coatings, namely, lead suboxide as a basic coating, iron oxide as an intermediate layer, and titan white as the top coating. It was found that, when the base board was merely plywood, the amount of stray radiation is higher with the coating than without. When 12-mm boards, 25-mm boards, and a 3-mm lead sheet were used as the bases, the protection values were 2.0, 2.8 to 2.9, and 1.3, respectively; these values, however, were not so high as those reported by Hashizume. (auth)

Theoretical Physics

12414 (NP-9824) SPIN PRECESSION OF A CLASSICAL PARTICLE. G. W. Ford and C. W. Hirt (Michigan. Univ., Ann Arbor). [1959?]. 15p. Contract Nonr 1224(15).

A discussion is presented of the equation of motion for the intrinsic angular momentum of a classical particle in a homogeneous external electromagnetic field. The antisymmetric tensor representation is first adopted for the intrinsic angular momentum, and then the most general equation of motion which is consistent with a set of reasonable restrictions is written. The resulting equation is essentially identical with that of Frenkel. The discussion is then

repeated using a four-vector representation to show the equivalence of the two approaches. The derived general equation of motion is used to obtain an explicit expression for the angular velocity of precession of the intrinsic spin. (J.R.D.)

12415 (NP-9855) ON THE TREATMENT OF A PERTURBATION IN A SYSTEM OF PAIRED FERMIONS. Amnon Katz (Weizmann Inst. of Science, Rehovoth, Israel). 1960. 13p.

A straightforward variational calculation with BCS wave functions yields expressions leading to a correct rotational moment of inertia of the system at the limit of a large system, to a correct mass in the pushing model, and to a gage invariant description of the Meissner effect. (auth)

12416 (NP-9904) SPIN PRECESSION IN CLASSICAL RELATIVISTIC MECHANICS. H. C. Corben (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Dec. 15, 1960. 21p. (STL/TR-60-0000-GR433)

The motion of a point particle with spin according to relativistic classical mechanics is shown to possess the following properties: (1) A free particle is not required to move along a straight line but may move along a helix in space or along a hyperbola in space-time; (2) the helical and hyperbolic motions are the classical analogues of zitterbewegung and pair production, respectively; (3) the effective mass M of the particle is in general not equal to its rest mass; (4) in a magnetic field B, the particle automatically possesses a magnetic moment $e\mathrm{B}\sigma/\mathrm{Mc}$, where σ is the spin; and (5) m is a constant of the motion in a uniform electric or magnetic field. (D.L.C.)

12417 (UCRL-Trans-638) RECONSTRUCTION OF POTENTIAL ENERGY BY THE PHASES OF SCATTERED WAVES. V. A. Marchenko. Translated from Doklady Akad. Nauk S.S.S.R., 104: 695-8(1955). 7p.

A mathematical analysis related to the reconstruction of potential energy by the phases of scattered waves is presented. (J.R.D.)

12418 DERIVATION OF THE FERMI-THOMAS EQUATION. A. A. Broyles (Univ. of Florida, Gainesville). Am. J. Phys., 29: 81-3(Feb. 1961).

A derivation of the Fermi-Thomas equation for a neutral atom is presented to show it as an approximation to the usual Hartree and WKB approximations. (auth)

12419 PARITY. Graham P. McCauley (Cornell Univ., Ithaca, N. Y.). Am. J. Phys., 29: 173-81(Mar. 1961).

The concept of parity conservation is the quantum mechanical expression of the intuitively reasonable hypothesis that the laws of physics do not distinguish between a system and its mirror image. An attempt is made to provide a nonmathematical account of the importance of conservation laws in elementary-particle physics and the way in which this hypothesis was built into our thinking in this field. The steps by which it was first called into question in the case of certain weak interactions are outlined, and a brief account is given of the experiments which demonstrated that the concept was not universally valid. (auth)

12420 QUANTUM FORMALISM ADAPTED TO RADIATION IN A COHERENT FIELD. Willard H. Wells (Jet Propulsion Lab., Pasadena, Calif.). Ann. Phys. (N.Y.), 12: 1-40(Jan. 1961).

Quantum-radiation theory in a coherent field was treated previously by conventional methods. The purpose of this report is to introduce a formalism that simplifies explicit calculations and improves understanding of the topic. The state of the radiation field is described by Wigner's probability density of position and momentum for each harmonic oscillator that represents a mode of the field. For oscillators, Wigner's density varies in time exactly like a classical density; i.e., probability propagates along space–time paths that obey the classical equation of motion. The new formalism exploits this appearance of a classical equation of motion in the quantum-mechanical problem. A method is devised for reducing atomic systems (matter) that interact with the field to impedance and noise, which enter into the equations of motion in the usual classical way. This description of matter reduces quantum-radiation theory to classical-noise theory of linear networks. As simple examples of the method, impedance and noise are derived for two systems: a general dissipative system, and the molecular beam of an idealized gas maser. The radiation theory is approached as the most obvious application of a more general theory of coupled systems. The general theory is presented first, applying Feynman's nonrelativistic space–time approach to the Wigner density. The mechanics of a system is described by the probability (in Wigner's sense) of each path of the coordinates in space–time. The influence of one system on another is described by the probability of a force function. (auth)

12421 MANDELSTAM REPRESENTATION FOR THE NONRELATIVISTIC MANY CHANNEL PROBLEM. L. Fonda and L. A. Radicati (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N.Y.), 12: 68-85(Jan. 1961).

The analytic properties of the transition amplitudes for the collision of two particles, each capable of a number of excited states and interacting through a set of generalized Yukawa potentials, was investigated. Double-dispersion relations for each of the amplitudes can be derived only when the reduced mass is the same for all channels and a certain stability condition which ensures the absence of anomalous thresholds, is satisfied. The Mandelstam representation is then discussed in connection with unitarity and the partial-wave expansion is obtained with results similar to the one-channel case. (auth)

12422 ON THE STRUCTURE AND PARITY OF WEAK INTERACTION CURRENTS. Feza Gürsey (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N.Y.), 12: 91-117(Jan. 1961).

The formulation of weak interactions by means of a current interacting with itself is generalized to the case in which $\mathrm{T} = {}^3/_2$ currents also exist, assuming the $\Delta\mathrm{T} = {}^1/_2$ rule to be valid. Furthermore, generalizing the Feynman–Gell-Mann theory, it is postulated that all the currents entering the weak interactions are conserved in the limit of meson masses and baryon mass differences being neglected. This restriction limits the isotopic spin of the currents to $\mathrm{T} = {}^1/_2$, 1, and ${}^3/_2$, if $\mathrm{S} = 2$ currents are excluded. Another consequence of the same hypothesis is that parity mixtures are allowed for the $\mathrm{T} = {}^1/_2$ and $\mathrm{T} = 1$ currents, but not for the $\mathrm{T} = {}^3/_2$ current. The five types of currents thus obtained (V and A currents with $\mathrm{T} = {}^1/_2$ and 1 and only V or A with $\mathrm{T} = {}^3/_2$) can be combined into a 4×4 matrix current J_χ. It is shown that a weak Lagrangian proportional to the trace of $J_\lambda^\dagger J_\lambda$ satisfies the $\Delta\mathrm{T} = {}^1/_2$ rule. In the absence of neutral lepton currents the charged lepton current is necessarily incorporated in a rather unsymmetrical manner, but in conformity with the $\Delta\mathrm{T} = {}^1/_2$ rule in strangeness changing leptonic decays. The scheme is applied to the decay of Σ hyperons. In the pionic decay of Σ^+, and in the lowest order in strong interactions, parity is conserved in the channel $\Sigma^+ \rightarrow \mathrm{n} + \pi^+$ and violated in the channel $\Sigma^+ \rightarrow \mathrm{p} + \pi^0$ if all the five types of current are present. The phenomenological Lagrangian of Bludman for Σ decay is obtained as a direct interaction from the terms of the weak

Lagrangian. Finally, a model of a baryon–meson nonlinear interaction generalizing a previous model is given in which all the five types of conserved currents are shown to exist. (auth)

12423 STATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. Bidyut Kumar Datta (Surendra Nath Coll., Calcutta). Ann. Phys. (N.Y.), 12: 295-9(Feb. 1961).

The equations of Rainich's "already unified theory" are solved for two simple types of static metrics: (1) where the space-time admits of a group of motion with minimum invariant varieties that are two-dimensional spacelike surfaces of constant negative curvature and (2) for a space exhibiting an abnormal spherical symmetry. In the first case, the solution bears a striking formal similarity to the Reissner–Nordstrom solution for a point charge, whereas the second case shows some interesting features. (auth)

12424 DYNAMIC CONTACT COMPRESSION AND COLLISION OF ELASTIC BODIES. N. A. Kilchevskii (Kiev Polytechnic Inst.). Dopovidi Akad. Nauk Ukr. R.S.R., No. 11, 1476-9(1960). (In Ukrainian)

The effect of local forces of inertia, which are neglected in Hertz's impact theory, on the interaction of colliding bodies is discussed. (auth)

12425 NEW TYPES OF INTERACTION IN THE NON-LOCAL MESIC FIELD THEORY. E. Arnous (Institut Henri-Poincaré, Paris). J. phys. radium, 21: 807-8(Nov. 1960). (In French)

Some experimental data, such as the mass difference between π and π^0, suggest the existence of a "coupling" of interactions in the vicinity of the nucleon mass. This coupling can be introduced in nonlocal theory by the intermediary of a form factor and Lorentz invariant. The types of interactions possible in electromagnetic and in mesic theory are given. (J.S.R.)

12426 STUDIES OF A FIELD MODEL WITH A ZERO RENORMALIZATION CONSTANT. J.-C. Houard and B. Jouvet (College de France, Paris). Nuovo cimento (10), 18: 466-81(Nov. 1, 1960). (In French)

It is shown in a solvable example that a Fermi coupling theory is equivalent to a Yukawa coupling theory in which the renormalization constant of the intermediate particle is zero. The nullification of this constant is then interpreted in a Lagrangian formalism as a limit imposed on fields. Finally, the singularity of the commutation relations is studied. (tr-auth)

12427 CELLULAR SPACE-TIME AND QUANTUM FIELD THEORY. A. Das (Inst. for Advanced Studies, Dublin). Nuovo cimento (10), 18: 482-504(Nov. 1, 1960). (In English)

A simple cellular model of space-time is introduced which incorporates a fundamental length in a natural way. The usual concept of field quantities as functions of geometrical points was rejected in favor of the concept of field quantities as functionals of elementary cells. Consequently the usual field equations in the form of partial differential equations were replaced by corresponding partial difference equations. Subsequent quantization yielded an S-matrix which is not vitiated by the presence of serious divergences. The basic space-time structure and the S-matrix (which does not involve derivative coupling) are shown to be integral Lorentz covariant. The semi-convergence or asymptotic behavior of the S-matrix series was established, and a meaningful Borel-sum of the "gross" S-matrix series is presented. (auth)

12428 REGULARIZATION AND RENORMALIZATION. III. FINITE-PART INTEGRALS. E. R. Caianiello (Univ. of Maryland, College Park), A. Campolattaro, and B. Preziosi. Nuovo cimento (10), 18: 505-24(Nov. 1, 1960). (In English)

The replacement of ordinary with finite-part integrals, which generalize the definition originally given by J. Hadamard, was shown previously to yield ipso facto correctly renormalized field equations independently of perturbative techniques, provided due care is taken of the symmetry properties of the theory and some quantitative conditions (closely related to Dyson's heuristic conditions for renormalizability) are satisfied by the theory itself. The class of finite-part integrals considered before was extended to cover all instances which may practically occur. Several possible prescriptions in configuration space which exhibit the wanted properties are discussed. It appears that some prescriptions are better suited to the study of general questions, such as renormalizability of a theory and deduction of the Lie equations of its renormalization group, while others are more convenient for actual computation, once renormalizability is proved. (auth)

12429 THE ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES IN SIXTH-ORDER PERTURBATION THEORY. G. Wanders (Universität, Hamburg). Nuovo cimento (10), 18: 580-94(Nov. 1, 1960). (In English)

The analyticity properties of the sixth-order contribution to the nucleon-nucleon scattering amplitude, as a function of two complex invariants, were investigated. The regularity domain in the first sheet of these invariants was obtained. This domain turned out to be identical with that implied by Mandelstam's representation. (auth)

12430 ANOMALOUS THRESHOLDS IN DISPERSION THEORY. PART I. R. Blankenbecler (Princeton, Univ., N. J.) and Y. Nambu. Nuovo cimento (10), 18: 595-607 (Nov. 1, 1960). (In English)

The form factor of a particle in the so-called anomalous case (loosely bound system) was studied from the viewpoint of: description in terms of a Schrödinger type wave function; perturbation theory; and dispersion theory. A description is given on how to calculate the absorptive part of a dispersion relation in the correct Riemann sheet. (auth)

12431 FIELD METRICS. II. A CORRECTION. P. Sen (National Physical Lab., New Delhi, India). Nuovo cimento (10), 18: 613(Nov. 1, 1960). (In English)

It was previously suggested that the field metrics and commutators are correlated, but the equation given, $T_E(\kappa\tau(\bar{1}))T_B^*(\kappa\tau(\bar{2})) = \tau(\bar{1}\,\bar{2})\,J_1(\kappa\tau(\bar{1}\,\bar{2}))$, is not the solution. In order to maintain the hypothesis it was found necessary to postulate that the τ space is also four-dimensional. (M.C.G.)

12432 ON CERTAIN REPRESENTATIONS OF THE DIRAC EQUATION. A. Chakrabarti (National Physical Lab., New Delhi, India). Nuovo cimento (10), 18: 615-22 (Nov. 16, 1960). (In English)

By a generalization of the transformation given by Eriksen, some representations of the Dirac equation are derived, particularly cases including the well-known ones of Foldy and Wouthuysen and of Cini and Touschek. A modification of the procedure gives a transformed hamiltonian $\alpha_i E$ (i = 1, 2, and 3), such that Γ_5, as defined by Cini-Touschek, has exactly the same form (namely, $\sigma_p\lambda$) as in their case. Some special features of this representation are discussed. (auth)

12433 ANALYTIC PROPERTIES OF BOUND STATES IN POTENTIAL THEORY. L. Bertocchi, C. Ceolin, and

M. Tonin (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo cimento (10), 18: 770-82(Nov. 16, 1960). (In English)

The analytic properties of the vertex functions of a composite particle (deuteron) are analyzed in a potential model. The results are compared with the "anomalous" singularities of the relativistic perturbation theory. (auth)

12434 FIELD-THEORETICAL DERIVATION OF THE TWO-BODY POTENTIAL. S. N. Gupta (Wayne State Univ., Detroit). Nuovo cimento (10), 18: 823-4(Nov. 16, 1960). (In English)

It is shown that the neglect of velocity-dependent terms in the derivation of the nonrelativistic nuclear potential (S. N. Gupta, Phys. Rev., 117: 1146(1960)) can be rigorously justified. (T.R.H.)

12435 DECAY-MODES OF THE SCHIZON. AN ISOBARIC SPIN ANALYSIS. R. C. Kumar (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 18: 856-63(Dec. 1, 1960). (In English)

An isobaric spin analysis of all possible decay modes of the schizon into two and three strongly interacting particles was made. (auth)

12436 A REMARK ON THE THEORY OF FERMIONS WITH HIGHER ORDER DERIVATIVES. H. M. Fried and J. Plebanski (Univ. of California, Los Angeles). Nuovo cimento (10), 18: 884-94(Dec. 1, 1960). (In English)

The problem of negative norms arising in a multi-fermion theory derived from a single Lagrangian containing derivatives of order higher than the first may be removed by the adoption of a suitable indefinite metric. Interaction S-matrix elements, calculated with the metric operator, are shown to be equivalent to those of the conventional theory. (auth)

12437 A ONE-DIMENSIONAL SOLUBLE MODEL OF QUANTUM FIELD THEORY WITH EXTERNAL FIELD. J. Šoln (Institute "Rudjer Bošković," Zagreb). Nuovo cimento (10), 18: 914-27(Dec. 1, 1960). (In English)

The one-dimensional model of interaction between the zero mass quantized Dirac field with a given time-dependent external field was solved exactly. The field operator ψ is given as a functional of the corresponding incoming field operator φ. The S operator was brought into the ordered form which gives the possibility of investigating any process for any strength of coupling. Finally the vacuum-to-vacuum transition is compared with the results given by M. Neuman. A. Salam, and P. T. Matthews. (auth)

12438 BOUND STATES, SHADOW STATES AND MANDELSTAM REPRESENTATION. T. Regge (Princeton Univ., N. J. and Univ. of Rochester, N. Y.). Nuovo cimento (10), 18: 947-56(Dec. 1, 1960). (NYO-9266). (In English)

A technique involving complex angular momenta was previously used in order to prove the Mandelstam representation for potential scattering. One of the results was that the number of subtractions in the transmitted momentum depends critically on the location of the poles (shadow states) of the scattering matrix as a function of the complex orbital momentum. The study of the position of the shadow states was carried out in greater detail. Related inequalities concerning bound states and resonances are given. The physical interpretation of the shadow states is discussed. (auth)

12439 STABILITY ANALYSIS OF CHARGED PARTICLE MOTION IN A BIOT-SAVART FIELD. L. Salvadori (Università, Naples). Nuovo cimento (10), 18: 967-81(Dec. 1, 1960). (In Italian)

A complete and rigorous analysis is presented of the stability of motions of charged particles in a Biot-Savart field. This situation, which was already discussed partially by Caianiello and Gatti because of its possible interest as a test case in problems regarding the design of accelerators or the confinement of accelerated plasma ions, was studied in detail. It is shown, in particular, that the customary approximate methods for the study of stability may easily lead to wrong conclusions. (auth)

12440 THE CONFORMAL INVARIANCE IN QUANTUM FIELD THEORY. J. Wess (Universität, Vienna). Nuovo cimento (10), 18: 1086-1107(Dec. 16, 1960). (In English)

The properties of a conformal invariant quantum field theory are considered. A short discussion of the conformal group in four dimensions and of the topology, introduced into the pseudo-euclidean space by this group, is given. With the help of the commutation relations the spectrum of the generators in Hilbert-space is investigated. It is found that the only possible discrete eigenvalue of P^2 and of the P^ν's is zero and that the generator for scale transformations S has a continuous spectrum. The eigenfunctions of S in the x-representation are calculated; they form a complete set. The conservation laws valid in an invariant theory and the commutation relations predict a certain form of the conserved quantities expressed in terms of the energy-momentum tensor and of the co-ordinates. For scalar, spinor, and vector fields the generators are derived by the action principle of Schwinger. (auth)

12441 EXCITONS AND PLASMONS IN SUPERCONDUCTORS. A. Bardasis and J. R. Schrieffer (Univ. of Illinois, Urbana). Phys. Rev., 121: 1050-62(Feb. 15, 1961).

The Anderson-Rickayzen equations of motion for a superconductor derived within the random-phase approximation are used to investigate the collective excitations of superconductors. A spherical harmonic expansion was made of the two-body interaction potential V(k,k') and a spectrum of excitations with energies lying within the energy gap 2Δ was obtained. These excitations may be characterized by the quantum numbers L and M involved in the potential expansion. For an L-state exciton to exist, the L-wave part of the potential must be attractive at the Fermi surface. Odd-L excitons have unit spin and may be considered as spin waves. For s-state pairing in the superconducting ground state, the plasmon mode corresponds to the L = 0 exciton, the energy of which is strongly modified by the long-range Coulomb interaction. For a general potential several bound states may exist for given L and M. If the L-wave potential is stronger than the s-wave part of the potential, the system is unstable with respect to formation of L-state excitons. In this case, the ground state is formed with L-state pairing. Corrections to the Anderson-Rickayzen equations are discussed which lead to a new set of exciton states if the L-wave potential is repulsive. These excitons are interpreted as bound electron-hole pairs, as opposed to the particle-particle excitons present with an attractive L-wave potential. (auth)

12442 A TWO-DIMENSIONAL RELATIVISTIC FIELD THEORY. P. Federbush (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 121: 1247-9(Feb. 15, 1961). (TID-6584)

A particular two-dimensional relativistic field theory is considered. In some limit as the masses of the theory go to zero it approaches the Thirring model. By means of a formal transformation of the field operators the hamiltonian is reduced to that of a free field. An improved perturbation expansion can be written down, necessitating only wave function renormalization, and it appears that the renormalized theory is consistent. The S matrix can be exhibited exactly, and though it leads to no physical scattering, it is not equivalent to the unit matrix. Finally the renormalized

current operator is displayed as a suitable limit of products of the renormalized field operators. The form of the result clearly separates the consistency problem in quantum electrodynamics from that of the "photon mass." (auth)

12443 SYMMETRY OF THE ND^{-1} SOLUTIONS FOR COUPLED SCATTERING AMPLITUDES. J. D. Bjorken (Stanford Univ., Calif.) and M. Nauenberg. Phys. Rev., 121: 1250(Feb. 15, 1961).

Proof is given that the ND^{-1} matrix solutions for coupled scattering amplitudes are symmetric, provided the given discontinuity of the scattering matrix across the unphysical cut is symmetric. (auth)

12444 NONCLASSICAL STRUCTURE OF THE ENERGY-MOMENTUM TENSOR OF A POINT MASS SOURCE FOR THE SCHWARZSCHILD FIELD. Frank R. Tangherlini (Univ. of North Carolina, Chapel Hill). Phys. Rev. Letters, 6: 147-9(Feb. 1, 1961).

The structure of the energy-momentum tensor T^{μ}_{ν} in Schwarzschild field equations is explored. The tensor is shown to have four nonvanishing components, $T^0_0 = T^1_1$, $T^2_2 = T^3_3 = -\frac{1}{2}\, T^0_0$, with $T^0_0 = m\delta(r)/2\pi r^2$. (D.L.C.)

12445 SUCCESSIVE APPROXIMATION METHODS IN CLASSICAL STATISTICAL MECHANICS. G. E. Uhlenbeck (Univ. of Michigan, Ann Arbor). Physica, 26: Suppl., S17-27(Dec. 1960). (In English)

Work on graph theoretical methods in classical statistics is summarized. The application of these methods to the calculation of the classical partition function for an N-particle system with additive two-body forces is described. The relation of the two basic theorems of Mayer's theory to the general theorems in the theory of graphs is indicated. The two Mayer theorems reduce the problem of calculating the partition function to the calculation of the star integrals. The different types of stars are classified according to their complexity or connectivity. Applications to calculations of partition functions in plasma are also discussed. (M.C.G.)

12446 ON THE DYNAMICAL DERIVATION OF EQUILIBRIUM STATISTICAL MECHANICS. I. Prigogine, R. Balescu, F. Henin, and P. Resibois (Université Libre, Brussels). Physica, 26: Suppl., S36-48(Dec. 1960). (In English)

Work on nonequilibrium statistical mechanics, which allows an extension of the kinetic proof to all results of equilibrium statistical mechanics involving a finite number of degrees of freedom, is summarized. As an introduction to the general N-body problem, the scattering theory in classical mechanics is considered. The general N-body problem is considered for the case of classical mechanics, quantum mechanics with Boltzmann statistics, and quantum mechanics including quantum statistics. Six basic diagrams, which describe the elementary processes of the dynamics of correlations, were obtained. (M.C.G.)

12447 EXTENSION OF DIAGRAM TECHNIQUE OF FIELD THEORY TO FERMI SYSTEMS WITH PAIRING PHENOMENON (WITH APPLICATION TO SPHERICAL NUCLEI). S. T. Belyaev (Beliaev). Physica, 26: Suppl., S181-7(Dec. 1960). (In English)

Ordinary graphical and field theory methods are not applicable to a nonideal Bose gas and a superconductor. However it is possible to introduce Green's functions and then consider the totality of graphs constructed from them. As an example, single-particle and collective excitations are considered for the case of a finite Fermi system. (M.C.G.)

12448 PERTURBATION THEORY IN FINITE NUCLEI. J. Da Providencia (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 77: 81-92(Jan. 1, 1961).

In the surface region of a nucleus the nucleon density is lower than in the interior, and it might be expected that this will reduce the effect of the Pauli principle in suppressing correlations. Since in light nuclei the surface region is more important, it was expected that the perturbation theory would work less well and correlations would be more important than in uniform nuclear matter. Calculations with a simple model for O^{16} showed that the second-order correction to the energy is almost exactly the same as for uniform nuclear matter, but that two-body correlations are indeed enhanced considerably. (auth)

12449 EXACT SOLUTION OF SCHROEDINGER'S EQUATION FOR THE MOTION OF ARBITRARY SPIN IN A CIRCULATING MAGNETIC FIELD. A. M. Fedorchenko (Kiev State Univ.). Ukrain. Fiz. Zhur., 5: 327-32(May-June 1960). (In Ukrainian)

A method is described for the exact solution of a nonstationary Schroedinger's equation describing the motion of arbitrary spin in a circulating magnetic field of the form $H_z = H_0$, $H_x = H \cos \omega t$, $H_y = -H \sin \omega t$. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

12450 (ANL-6248) TERMINAL REPORT ON THE BOILING SLURRY REACTOR EXPERIMENT (SLURREX). G. A. Freund, J. D. Lokay, G. C. Milak, and J. C. MacAlpine (Argonne National Lab., Ill.). Dec. 1960. 97p. Contract W-31-109-eng-38.

A plant layout of SLURREX was prepared on the basis of preliminary design and sizing of major components. The reactor vessel was designed in detail, assuming the use of commercially available fittings. A hydraulic analysis of this vessel indicated that the design power of 5 Mw could be extracted with 50% exit steam voids. A half-scale mock-up of the reactor vessel was designed and constructed to verify experimentally the results of the theoretical hydraulic analysis. Physics calculations have allowed the selection of core parameters and have indicated that about 545 g of thoria (containing 10% of 93%-enriched urania) per kg of water is required for design power at 10.2-atm saturation pressure. An initial hazards analysis has shown that SLURREX can be operated safely at the proposed site near EBR-II at the National Reactor Testing Station. Preliminary determinations of process variables for measurement, alarm, and scram were made, and some selection of instrument types was carried out. (auth)

12451 (ANL-6269) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT. N. Hilberry (Argonne National Lab., Ill.). November 1960. 70p. Contract W-31-109-eng-38.

General research and development are reported on water-cooled and sodium-cooled reactors. Studies are also reported on reactor safety and nuclear technology. (For preceding period, see Report ANL-6253.) (W.L.H.)

12452 (ANL-6307) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JANUARY 1961. (Argonne National Lab., Ill.). Feb. 15, 1961. 71p. Contract W-31-109-eng-38.

Modifications of EBWR are described, and data from analysis of control-rod operational crud deposit are tabulated. Development and construction progress on Borax V are summarized. Research for ZPR III is reported on a series of uranium oxide critical cores. Comparative data on composition, critical masses, and central fission ratios are tabulated for these assemblies. Developmental work

on ZPR-VI, ZPR-IX, and Juggernaut is summarized, followed by a summary of EBR-I operation and development of EBR-II. Studies of reactor steam superheating concepts are reported from which conclusions are listed. In reactor safety studies, data were obtained on the extent of water reaction with various metal combinations for use in cores as function of energy input. In other work in-pile melt down studies were conducted. Operation and development of TREAT are described. Nuclear technological developments are summarized in sections on physics, fuel development, reactor components and materials, separations development, and advanced reactor development. (For preceding period see ANL-6295.) (J.R.D.)

12453 (APAE-78(Vol.IV)) INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR FINAL DESIGN. OPERATION AND MAINTENANCE. (Alco Products, Inc., Schenectady, N. Y.). Sept. 30, 1960. 89p. Contract AT(11-1)-666.

Information is given on installation and shipping, scram and casualty shutdowns, leaks, and instrumentation and control. (W.L.H.)

12454 (BAW-47) AN ANNOTATED BIBLIOGRAPHY ON HEAVY WATER AND HEAVY WATER REACTORS. Ann T. Curran (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Feb. 1958. 69p.

About 600 annotated references are presented on the properties and production of heavy water, the physics of heavy water and heavy water reactors, and the technology of heavy water reactors. The sources included Abstracts of Classified Reports, 1953 to 1956, Confidential Reports for Civilian Applications, 1955 to 1957, Secret Reports for Civilian Applications, 1956 to 1957, Nuclear Science Abstracts, 1948 to 1957, Chemical Abstracts, 1953 to 1955, and Industrial Arts Index, 1953 to 1957. (T.R.H.)

12455 (CEA-1673) FLUCTUATIONS STATISTIQUES DANS LES PILES. (Statistical Fluctuations in Reactors). V. Raievski (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 59p.

The theory of space-dependent fluctuations is developed, taking into account the effect of delayed neutrons. The "diffusion equation" or Fokker-Planck equation is worked out in the case of age and two-group theory, but the first one because of its physical significance is used in this report. The theory is applied to the study of the spectral density of fluctuations and fluctuations of counting rate and current flowing through the charge resistor of an ionization chamber; the effect of the entrance capacity is discussed. The space-dependent theory shows that the fluctuations in the core and reflector of a near-critical pile obey the same law. The spectral densities in the core and reflector are similar; there is no sensible attenuation of high-frequency fluctuations in the reflector. Compared to the space-independent theory, this theory gives better agreement with experience. One can use the simple space-independent theory but in checking with experiment it is necessary to introduce numerical factors given by the space-dependent theory. (auth)

12456 (CEA-1686) CALCUL DES BARRES DE CONTROLE DANS UN REACTEUR RECTANGULAIRE ET APPLICATIONS. (Calculation of Control Rods in Rectangular Reactor and Applications). S. Goshen and A. Pazy (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 43p.

The aim of this report was to find a method for estimating the antireactivity of control rods perpendicular to the axis in a cylindrical pile. The paper is divided into two parts. In the first is given a method of calculating control rods in a rectangular pile, similar to the Nordheim-Scalettar method for cylindrical piles. As an example the formulas are given for the theories of one- and two-neutron groups, the generalization for several groups being evident. In the second part by a variation method a formula is found for estimating the Laplacian of a pile, which may be divided into parallelepipeds for which the Laplacians are given. Finally, this formula is used to calculate the antireactivity of rods perpendicular to the axis in a cylindrical pile. (auth)

12457 (CF-58-7-116) NOTES ON GAS-COOLED $Th-U^{233}$ BREEDER REACTOR. Alfred M. Perry (Oak Ridge National Lab., Tenn.). July 28, 1958. 10p.

Conditions are discussed in which a fixed-fuel reactor may be expected to have a reasonably short doubling time with the $Th-U^{233}$ breeding cycle. A specific reactor concept is suggested which may have promise of fulfilling these conditions. (auth)

12458 (CF-61-1-59) XENON AND SAMARIUM POISONING. R. S. Carlsmith (Oak Ridge National Lab., Tenn.). Jan. 23, 1961. 14p.

The equilibrium and maximum override values for xenon and samarium poisoning were computed using recently issued effective cross sections. Values are given as a function of specific power, neutron temperature, and epithermal flux content. (auth)

12459 (CRCE-926) EVALUATION OF SOME POSSIBLE DECONTAMINATING REAGENTS FOR THE NRU REACTOR. S. R. Hatcher (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). May 1960. 64p. (AECL-1116).

A series of out-pile laboratory and loop tests was conducted to find a suitable reagent that could be added to the NRU heavy-water system to remove uranium contamination. The choice of reagent and its concentration is governed by corrosion of the aluminum components of the system and the ease of removal of the reagent from the heavy water after decontamination. The most attractive reagent tried was chromic acid at a concentration of 10^{-2}M. This reagent attacks UO_2 and removes deposited uranium from aluminum surfaces, but, at the same time, it is an inhibitor of aluminum corrosion. At a concentration of 10^{-2}M, it could easily be removed from the system by evaporation and ion exchange. No deuterization would be necessary before adding the acid to the heavy water. (auth)

12460 (GAMD-1892) TEMPERATURE DISTRIBUTION AND THERMAL STRESSES IN A SLAB WITH EXPONENTAL HEAT SOURCE. H. F. Menzel (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 5, 1961. Project No. 32. Contract AT(04-3)-314. 11p.

Temperatures and temperature gradients from γ heating in reactor components are treated for more complicated cases than are found in the literature. A summary of available solutions for conditions which may arise in designing the reactor vessel and its components is attempted. The basic stress formula for the case of an exponential heat source in slab geometry is derived, into which the appropriate temperature equation can be inserted. (T.R.H.)

12461 (HW-60026) MULTI-REGION SIMULATION OF XENON POISONING IN THE PRTR. W. D. Cameron (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 13, 1959. 21p. Contract AT(45-1)-1350.

A study is reported on the buildup and decay of xenon in the Plutonium Recycle Test Reactor. The study was made by dividing the reactor into six regions and calculating the

poisoning in each region, as well as the effective poisoning for the entire reactor. The method was to simulate the problem on an analog computer. (W.L.H.)

12462 (IDO-16634) SPERT PROGRAM REVIEW. W. E. Nyer and S. G. Forbes (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). October 19, 1960. 44p. Contract AT(10-1)-205.

The Reactor Safety Program is centered on those problems associated with the operation of nuclear reactors which involve the possibility of extreme hazards. The program involves studies of reactor dynamics, chemical reactions, and reactor containment. The earliest large-scale experimental work was the Borax series of tests. The principal objectives of the Borax series were related to the feasibility of boiling reactors but included the study of the self-limiting properties of such systems when subjected to sudden large additions of reactivity. Studies on the maximum step and ramp additions of reactivity that can safely be introduced into a few selected types of reactor cores were completed. Spert-II will be used to examine the influence of prompt neutron lifetime and to study the influence of special factors connected with the use of heavy water. Spert-III will be used to assess the importance of pressure and temperature, as well as other special factors, in power plants operating with boiling- and pressurized-water reactors. Spert-IV will be used for investigating self-induced oscillations. Extensive changes are proposed in the Spert-I program. (W.L.H.)

12463 (KAPL-M-FPR-1) A STUDY OF ERBIUM OXIDE USED AS DISTRIBUTED REACTOR POISON. D. R. Bach, F. DuBois, J. R. Dwyer, G. D. Hickman, P. G. Klann, and L. A. MacNaughton (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 16, 1960. Contract W-31-109-Eng-52. 63p.

Two cores containing different amounts of fuel, aluminum, and erbium oxide on mylar tape, were constructed in the Flexible Plastic Assembly. These cores had $\beta\gamma$ values of 0.196 and 0.486. Measurements were made in the core of reactivity coefficient of core constituents, various rod worths, and thermal and fast neutron distributions. Where possible, the experimental results were compared with calculated values. Extensive calculations using MUFT-SOFOCATE and MUFT-SWAKRAUM were also made in an attempt to calculate the eigenvalues for the critical cores. The results of this study showed that the addition of erbium does not materially affect the ability to calculate reactor parameters. The main discrepancies between experiment and calculation appear to be due to the presence of a large amount of aluminum in those cores. (auth)

12464 (KAPL-M-RJR-3) A COMPARISON OF EXPERIMENTS AND THREE-DIMENSIONAL ANALYSIS TECHNIQUES. PART I. UNPOISONED UNIFORM SLAB CORE WITH A PARTIALLY INSERTED HAFNIUM ROD. N. E. Renzi and R. J. Roseberry (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 12, 1961. Contract W-31-109-Eng-52. 43p.

The experimental measurements and nuclear analysis of a uniformly loaded, unpoisoned slab core with a partially inserted hafnium rod are described. Comparisons of experimental data with calculated results of the UFO code and flux synthesis techniques are given. It was concluded that one of the flux synthesis techniques and the UFO code are able to predict flux distributions to within ~5% of experiment for most cases. An error of ~10% was found in the synthesis technique for a channel near the partially inserted rod. The various calculations were able to predict neutron pulsed shutdowns to only ~30%. (auth)

12465 (NAA-SR-5418) KINETIC EXPERIMENTS ON WATER BOILERS—"A" CORE REPORT. PART IV—CONTAINMENT ASPECTS OF HYDROGEN-OXYGEN EXPLOSIONS. M. A. Greenfield (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 34p. Contract AT(11-1)-GEN-8.

The conventional method of estimating the internal pressure at which a vessel will fail leads to overestimates of the strength for static loading and an underestimate of the strength for a range of dynamic loadings. A theory that connects the time duration of the applied pressure and the effects of plastic flow is shown. The conclusion reached, in the example chosen, is that a reactor vessel can withstand a maximum pressure, occurring in a hydrogen—oxygen explosion, approximately twice the amount indicated by an analysis of a static loading. (auth)

12466 (NAA-SR-5419) KINETIC EXPERIMENTS ON WATER BOILERS. "A" CORE REPORT. PART V. CONTAINMENT ASPECTS OF PRESSURE WAVES FROM SOLUTION EXPANSION. M. A. Greenfield (Atomics International. Div. of North American Aviation, Inc. Canoga Park, Calif.). Feb. 15, 1961. 31p. Contract AT(11-1)-GEN-8.

A theoretical treatment is made of the stress-strain and plastic flow properties of spherical shells of stainless steel under dynamic loading. The results are used to calculate the response of a homogeneous reactor core to inertial pressure pulses. The importance of the duration of the pressure pulse as compared with a natural time or period of the material in plastic as well as in elastic deformation is noted. For a small homogeneous reactor core vessel, the natural plastic "swing time" is found to be about 0.25 msec. The rise time of the pressure pulse is 2.5 msec while the decay time is approximately 12.5 msec. Thus the rise time of the pressure pulse is about 10 times as large as the "swing time," which means the static pressure approximations hold quite well, and maximum energy absorption is determined for the conditions under which the vessel will fail. (auth)

12467 (NAA-SR-Memo-3015) FISSION PRODUCT POISONS AND FAST TRANSIENTS. R. E. Skinner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 21, 1958. 10p.

It has been suggested that a short-lived fission product poison may explain the observed rapidity of shutdown after the peak for fast transients in reactors such as SPERT-I. This hypothesis was investigated in some detail. (W.D.M.)

12468 (NAA-SR-Memo-3484) FUEL ELEMENT PARAMETERS USING A SQUARE THERMAL COLUMN. J. W. Zink (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 27, 1959. 11p.

The heterogeneous method of calculating the critical buckling of heterogeneous thermal reactors involves parameters which characterize the moderator and fuel elements. The moderator parameters (namely, age, diffusion length, and diffusion constant) can be determined by well-known methods. The fuel-element parameters, blackness, multiplication, and a resonance parameter can be determined by measurements about a single fuel element in a thermal column. The details of this procedure for a cylindrical thermal column were described previously. The use of a square thermal column requires some modification of the mathematics. The mathematical analysis for the square thermal column and an outline of the necessary experimental measurements are given. (auth)

12469 (NDA-2145-6) CARBIDE FUEL DEVELOPMENT. Phase II Report, Period of September 15, 1959 to September 15, 1960. C. Bolta and A. Strasser (Nuclear Development Corp. of America, White Plains, N. Y.). P. Doherty, F. Saulino, and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). Nov. 6, 1960. 84p. Contract AT(30-1)-2303.

Uranium monocarbide powder having a good purity (average UC content of about 97%) was obtained by carbon reduction of UO_2. The chief impurities were UO_2 and UC_2. In addition, traces of nitrogen (less than 0.1%) were usually present. A preliminary study of the production of UC by the reaction of carbon with ammonium diuranate indicated that a good product can probably be obtained by this method. Pellets of UC with natural uranium were fabricated by cold pressing at 16,000 psi and sintering at 1850°C for 1 hr. Average densities of 12.7 g/cm^3 (93% of theoretical) and maximum densities of 13.0 g/cm^3 (95% of theoretical) were achieved. Small particle size, about 1 μ, was found to be of prime importance in achieving high densities. Varying cold forming pressure from 15,000 to 40,000 psi and sintering at temperatures higher than 1850°C did not improve sintered densities. Approximately ½% of a temporary binder, Carbowax 6000, gave the best results. The structure of the pellets consisted of UC and a small amount of UC_2. Pellets of UC with 24% enriched uranium were fabricated for irradiation tests by the same methods. Average densities of 12.8 g/cm^3 (94% of theoretical) and maximum densities of 13.1 g/cm^3 (96% of theoretical) were achieved. The structure of the pellets consisted of UC and indications of free uranium metal. The deliberate addition of uranium metal in amounts up to 10% of the UC powder did not greatly increase the final density of the pellets. Hot pressing of UC powder did not result in better densities than had been obtained by cold pressing and sintering. Simultaneous synthesis and fabrication of UC was tried by hot pressing uranium metal powder and carbon. Densities of 13.0 to 13.3 g/cm^3 were obtained. The pellets contained a major UC phase and a nonuniform distribution of free uranium metal. UC was held in contact with various cladding materials at 820°C up to 4000 hr, to study possible fuel-cladding interactions. There was no reaction or barely detectable reaction with niobium and 2½ Cr-1 Mo steel. A slight reaction occurred with type 304 SS, and a considerable reaction occurred with Inconel-X, Zircaloy-2, and beryllium. The type 304, 2¼ Cr-1 Mo steels and niobium appeared to be satisfactory cladding materials for UC under the conditions of the test. The dissolution study of a few UC pellets containing simulated fission products (fisside) was completed. High uranium recovery was achieved. Eight irradiation capsules are planned. Variables to be investigated are burnup (2, 4, and 8% of all fuel atoms), maximum fuel temperature (980 and 1370°C), power (14 and 20 kw/ft), effect of cladding coefficient of expansion on maximum fuel temperature (niobium and stainless steel). A measure of effective in-pile thermal conductivity and gas release will be attempted. The Carborundum Company plutonium facility and the NDA plutonium facility were completed. (auth)

12470 (NP-9806) RELATION BETWEEN DENSITY FLUCTUATIONS AND REACTOR POWER FLUCTUATIONS. Richard L. Moore (Moore (Richard L.) Consultants, Los Angeles). Aug. 17, 1960. Revised, Jan. 30, 1961. 49p.

Previous analyses of reactor kinetic behavior are shown to be in error because of neglect of the coupling between the rate of change of density (and/or temperature) and the neutron power level. Illustrations are given of ways in which this coupling occurs. The first-order corrections are obtained for the case of a transient in a reactor with a 1/v scattering law where bubbles are formed without expansion of the material, and for the case where the macroscopic density varies uniformly. Corrections are found which are important for power transients of period of 10^{-2} sec or less or for cases of rapid bubble formation and dissolution at a steady power condition. The conditions are obtained under which the basic assumption of ordinary reactor kinetics that the "convective" terms are zero is a good approximation. Serious error may be made in reactor safety analyses if these terms are not shown, by experiment, to be small. (auth)

12471 (TID-8200(2nd Rev.)) NUCLEAR REACTORS BUILT, BUILDING, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1960. (Office of Technical Information, AEC). 23p.

Information is presented in five parts, categorized by primary function or purpose. The first four categories include civilian, military, production, and export reactors. The fifth is devoted to critical assemblies. (W.L.H.)

12472 (TID-8200(3rd Rev.)) NUCLEAR REACTORS BUILT, BUILDING, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1960. (Office of Technical Information, AEC). 27p.

Information is presented in five parts, each of which is categorized by primary function or purpose. The first four categories include civilian, military, production, and export reactors. The fifth is devoted to critical assemblies. (W.L.H.)

12473 (TID-11158) HYDRAULIC CONTROL ROD DRIVE MECHANISM. Monthly Report No. 7 [for] Period Nov. 1–Nov. 30, 1960. R. B. Hussey (American Bosch Arma Corp. American Bosch Div., Springfield, Mass.). Dec. 7, 1960. 9p. Contract AT(30-1)-2529.

A new servo unit was designed to replace the original control sleeve which was not feasible due to excessive binding. The basic concept contained hydraulic feedback within the power unit. This feature is retained in the new design through the use of a zero backlash linkage between the main piston and the servo unit. The design incorporates features that prevent jamming, reduce leakage, and improve control. Drawings are included. (W.L.H.)

12474 (TID-11163) HYDRAULIC CONTROL ROD DRIVE MECHANISM FEASIBILITY STUDY. MATHEMATICAL ANALYSIS. R. B. Hussey and C. F. Cartledge (American Bosch Arma Corp. American Bosch Div., Springfield, Mass.). Dec. 5, 1960. 36p. Contract No. AT(30-1)-2529.

A mathematical analysis is presented of hydraulic control-rod-drive mechanism scram, hydraulic power requirements, position resolution, and piston dynamics. (W.L.H.)

12475 (TID-11295) NUCLEAR FUELS AND MATERIALS DEVELOPMENT. (Division of Reactor Development, AEC). Feb. 1961. 172p.

A summary is presented of work being done under the Nuclear Technology program of the Division of Reactor Development to increase knowledge of and effect improvements in reactor materials. The mechanism of swelling in irradiated metallic fuel elements is being investigated. Feasibility of producing uranium alloys of improved irradiation stability by applying a novel fabrication technique is under investigation. The development of Zr–U–Th, Th–U–Mo, and Th–U–Zr–Nb alloys possessing improved elevated temperature and mechanical properties for power reactor applications is presented. It was demonstrated that considerable

savings in cost may be achieved in aluminum plate type fuel elements which are limited to 20% U^{235} enrichment. The coating of UO_2 fuel particles with Cr–Nb, W, Mo, Nb, Nb–V, and Al_2O_3 and dispersion of the fuel particles in various matrices are reported. The development and testing of fully enriched, homogeneous ceramic fuel are reported. The application of UO_2–ZrO_2–CaO fuel to boiling-water reactors is discussed. The effects of additives on the thermal conductivity of UO_2 are being investigated. Research is reported on the Th–U^{233} fuel cycle. A program is described for developing methods of producing improved aluminum-base fuel elements in which the fuel is contained in Fiberglas embedded in an aluminum matrix. An investigation is reported on the synthesis and fabrication of uranium carbide, uranium nitride, and uranium silicide. The preparation and properties of PuO_2, PuC, Pu_2C_3, and PuN are under study for power reactor applications. The development of cladding and container materials is reported. The existence of a body-centered cubic phase in beryllium at temperatures above 1260°C was confirmed. Factors influencing the ductility of Fe–Al alloy were studied. The effect of O_2, N_2, and H_2 on the mechanical properties of niobium was investigated. The effect of environment on the creep properties of type 304 stainless steel was investigated at elevated temperatures. The corrosion of cladding material in high-temperature water and liquid metal was investigated. The thermal stress fatigue behavior of Zr and Zr alloys was investigated. The preparation and properties of yttrium are being investigated. The properties and characteristics of pressure vessel materials and stress analysis methods for pressure vessels are reported. The preparation and properties of the following control rod materials are reported; rare earths, rare-earth oxides, metal borides, Hf, In, Ag, Ta, and Au. Research on reactor moderator materials included water, heavy water, beryllium oxide, beryllium, graphite, and metal hydrides. Fabrication techniques are reported for various types of reactors fuels. Methods for nondestructively testing reactor components are reported. (W.L.H.)

12476 (WAPD-TM-208) BRIC–AN IBM-704 TWO-DIMENSIONAL NUCLEAR-THERMAL DEPLETION PROGRAM WITH DISTRIBUTED VOID EFFECTS. W. M. Jacobi, T. J. Lawton, S. H. Meanor, and J. R. Parrette (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT(11-1)-GEN-14. 30p.

BRIC is a two-dimensional nuclear-thermal depletion program to study the effects of moderator boiling on the neutron flux distribution and the depletion of the time-dependent isotopes. The program requires an IBM-704 with a memory of 32,768 words and ten tape units. (auth)

12477 (WAPD-TM-220) CALCULATION OF THE BACKGROUND NEUTRON SOURCE IN NEW, URANIUM-FUELED REACTORS. D. R. Harris (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). March 1960. 36p. Contract AT-11-1-GEN-14.

Methods of calculation of the strengths of background neutron sources for uranium-fueled reactors are presented. The discussion of spontaneous fission is a review of the existing experimental data, although semiempirical estimates of the mean numbers of neutrons emitted in spontaneous fission of $U^{234-236}$ are included. In the case of (α,n) reactions produced by alpha particles from uranium radioactivity, measured alpha slowing down data are combined with measured and calculated (by the continuum theory) cross sections to produce a table of yield integrals which can be applied to calculation of the (α,n) neutron yield. The cosmic-ray neutron source strength is obtained by a reworking of existing experimental data combined with a plausible model of the source mechanism. The calculational methods are reviewed and applied to sample reactor cases, and calculated background source strengths are compared with available measured values. In treatments of weakly multiplying reactors as stochastic processes, it is useful to know the multiplicity of neutrons emitted in source events such as spontaneous fission. Multiplicities, when known, are presented. (auth)

12478 (WAPD-TM-254) MEASUREMENT OF THE NATURAL NEUTRON SOURCE IN TWO CORES. W. B. Doub and S. Milani (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1960. Contract AT (11-1)-GEN-14. 18p.

The natural background neutron source was measured for two cores in a critical facility. The primary neutron source was from spontaneous fission for the first core and from the B (α,n) reaction in the boron-loaded fuel meat for the second core. The natural sources were measured by comparing the detector response induced by them with respect to the detector response induced by a Po–Be source of known strength in the nearly critical cores. The measured values were in nominal agreement with the calculations of D. R. Harris. (auth)

12479 (CEA-tr-R-1131) RÉACTEUR NUCLÉAIRE PULSÉ. (Pulsing Nuclear Reactors). T. N. Zubarev. Translated into French by B. Vinogradoff from Atomnaya Energ., 5: 605-17(1958). 34p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 5922.

12480 (DEG-Inf-Ser-98) UNSTABLE OSCILLATIONS IN BOILING-WATER REACTORS. M. Ledinegg. Translated by L. H. Sinclair from Atomkernenergie, 4: 132-5(1952). 1960. 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 14101.

12481 (UCRL-Trans-629(L)) ABOUT THE LINEAR EXTRAPOLATION LENGTH ON THE SURFACE OF AN INFINITE PLANE. M. Angelopoulos. Translated from Atomkernenergie 5: 217-22(June 1960). 21p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 18579.

12482 (UCRL-Trans-631(L)) ABOUT A METHOD FOR THE EXPERIMENTAL DETERMINATION OF THE FLUX DISTORTION IN A HETEROGENEOUS REACTOR STRUCTURE. A. Ziegler. Translated from Nukleonik, 1: 295-305(1959). 39p. (Includes original, 10p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 3187.

12483 REPLACEMENT OF A BLOCK IN A TWO-DIMENSIONAL RECTANGULAR ARRAY. L. Trilifaĭ and J. Rochek. Atomnaya Energ. 9: 366-74(Nov. 1960). (In Russian)

The cell replacement in an infinitely two-dimensional heterogeneous rectangular array by another cell with different properties is analyzed. Two methods are used, depending on the subcriticality or supercriticality of the infinite lattice. Both methods supplemented and checked each other. The method used in quantum field theory was applied in the case of breeding medium. The critical infinite lattice is considered as the maximum case for both described conditions. The results corresponding to the homogeneous analogy of the examined problem are derived for the lattice under the conditions of homogenization. (R.V.J.)

12484 A CRITERION FOR INSTABILITY DUE TO TEMPERATURE TRANSIENTS. R. D. Jain (Dzheĭn)

and R. S. Desai. Atomnaya Energ. 9: 375-86(Nov. 1960). (In Russian)

The kinetics of uranium–graphite Calder Hall type reactor were studied considering the effects of the reactivity temperature coefficient and its variations in the fuel burn-up process. The conditions of reactor instability are found, and it is shown that with the burn-up of 3000 Mwd/t the minimum positive period of a Calder Hall type reactor is not less than 170 sec. (tr-auth)

12485 THE BACKGROUND NOISE OF NUCLEAR REACTORS. A SIMPLE RADIOELECTRIC MODEL. Augustin Blaquiere and Roza Pachowska. Compt. rend., 251: 2918-20(Dec. 19, 1960). (In French)

A new method for the study of the neutron background noise of reactors is introduced. A simple radioelectric model is deduced which permits the rapid obtention of the least square of the density fluctuations and the frequency spectrum of the background. (tr-auth)

12486 ORGANIC COMPOUNDS AS MODERATOR-COOLANTS FOR NUCLEAR REACTORS. Ricardo Fernández Cellini, Felipe de la Cruz Castillo, and Rosendo Barrera Piñero. Energia nuclear (Madrid) 4: No. 14, 49–64(April–June 1960). (In Spanish)

A review is presented on the utilization of organic compounds as reactor coolants and moderators. The properties necessary for moderators and coolants are first considered; then the criteria used for the selection of the specific organic compound for this utilization are summarized. The properties of polyphenyls as reactor coolants and moderators are discussed. Coolant stability, coolant activation, and heat transfer in the Organic-moderated Reactor Experiment are considered. The chemical control of an organic moderator-coolant is discussed in conclusion. (J.S.R.)

12487 THERMAL PARAMETERS FOR THE PLANNING OF WATER COOLED NUCLEAR REACTORS. Germano Polano (Ufficio Tecnico della Marina Militare, Livorno, Italy). Ing. nucleare, 5: 191-204(Sept.-Oct. 1960). (In Italian)

Water-cooled nuclear reactors are planned for thermal flows having a burn-out limit. A better knowledge of the parameters influencing heat transmission, especially those relative to burn-out flow, makes it possible to reduce planning doubts. The parameters are considered for the case of pressurized-water reactors. The subject matter is subdivided into the following chapters: (1) criteria followed in the choice of hot-channel factors, (2) determination of spatial distribution of thermic conditions, and (3) use of empirical correlations for burn-out flow. (auth)

12488 ANALYSIS OF TRANSIENT BEHAVIOR IN THE SPERT-1 REACTOR EXPERIMENT. Shigenori Hayashi, Jiro Wakabayashi, Akira Sakurai, Tetsuo Iwasumi, Hideto Aoki, and Motohiko Kitamura (Kyoto Univ.). J. At. Energy Soc. Japan, 3: 1-8(1961). (In Japanese)

The SPERT-1 reactor experiment was studied and the results of the analysis were compared with experiments. Analyses were made previously by S. G. Forbes, et al., using the modified Fuchs model, but this method cannot be used to estimate exactly the transient behavior of the reactor in advance. This study however was based on the conduction boiling model using design data and experimental results on transient heat transfer and transient boiling. It is shown that transient heat transfer before boiling occurs; and heat transfer from fuel to aluminum cover, delay time of boiling, boiling temperature rise due to pressure rise, and the lifetime of bubbles are important factors in the analysis of transient behaviors of the reactor. The results of the analysis were in agreement with experiment. (auth)

12489 A PROBLEM OF THERMAL SHOCKS IN THE MAIN GAS DUCTS OF A NUCLEAR POWER STATION WITH A REACTOR OF SMALL THERMAL INERTIA. Ladislav Bohal. Jaderná energie, 6: 398-403(1960). (In Czech)

The problem of thermal shocks in main gas ducts of a nuclear power station with a reactor of small thermal inertia is discussed. Methods of numerical calculation of temperatures and additional stresses are reported. The importance of practical precautions for diminishing thermal shocks is outlined. Analysis of the number of shocks is of great importance for the evaluation of safety from the point of view of periodical strain. Experience gained in the solution of these problems for the first Czechoslovak nuclear power station is described. (auth)

12490 DESIGN AND MANUFACTURE OF REACTOR VESSELS. D. K. Davies (Babcock and Wilcox Co., Barberton, Ohio). Metal Progr., 79: 101-4; 148; 153A; 153C; 154(Mar. 1961).

Difficulties in the design and manufacture of pressure vessels arising from ignorance about radiation damage to steel and welds, from laminations and inhomogeneities in the plate, and from lack of standardized test and inspection methods are discussed. Recommendations for overcoming some of these problems are given. (M.C.G.)

12491 HOMOGENEOUS REACTORS. GENERALITIES. RESEARCH HOMOGENEOUS REACTORS. POWER HOMOGENEOUS REACTORS. Michel Frenon (Commissariat a l'Energie Atomique, Paris). Nature, (Paris), No. 3882, 16p.(Oct. 1958). (In French). (CEA-1076)

Having located and underlined the importance of homogeneous reactors with regard to the types of reactors, the characteristics of homogeneous reactors are given and the different problems which arise for such reactors are discussed. The track of homogeneous reactors was explored by different countries. Some research (Lopo, Hypo, Supo, Borax, Proserpine, etc., and power reactors (H. R. T) are described briefly and completely. An evident advantage of this type of reactor is revealed. (auth)

12492 AN APPROACH TO REACTOR PHYSICS USING RESULTS OF INTEGRAL EXPERIMENTS. Karl H. Puechl (Nuclear Materials and Equipment Corp., Apollo, Penna.). Nuclear Sci. and Eng., 9: 241-59(Feb. 1961).

An approach to reactor physics was developed by analysis of experimental data on ordinary water, slightly enriched uranium lattices. The developed procedure is extremely simple; and, for these particular lattices, it is demonstrated that the thermal utilization factor and resonance escape probability can be calculated to satisfactory accuracy. Generalization of the procedure to all types of lattices is discussed, and a number of graphite-moderated lattices are analyzed. However, detailed analysis of further experimental data is required before the generalization can be used with complete confidence. To illustrate the reasonableness of the proposed general approach and hence the desirability for continued investigation along these lines, results of criticality and core-life calculations are presented for the Calder Hall reactor and for the Yankee reactor with various enrichments. (auth)

12493 ON THE MAXIMIZATION OF THE SENSITIVITY OF A FUEL ASSAY REACTOR. Henry A. Sandmeier (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 260-70(Feb. 1961).

To test reactor fuel elements for their content of fissionable material and poison, it is desirable to have an assembly that has maximum sensitivity to a perturbation of fissionable absorber in the axial center line of the reactor.

For normal sizes of thermal power reactor fuel elements, a graphite-moderated reactor is a suitable choice. The change in reactivity measured is the difference between the effect of changes in the fission and absorption parameters. For a bare core and uniform fuel distribution, maximum sensitivity to a fission-parameter-perturbation was obtained for a reactor that had a minimum critical mass. Maximum sensitivity to an absorber-parameter-perturbation was obtained for a reactor that had a minimum amount of total absorptions. Both the fission and absorption sensitivity reached a maximum when the critical mass was minimum. For a reflected core and uniform fuel distribution, the sensitivity to a fissionable absorber could be increased 22% over the bare core sensitivity. By introducing an internal and external reflector, the sensitivity to a fissionable absorber could be increased 30% over the externally reflected core and 56% over the bare core. For nonuniform fuel distribution, an expression was derived relating the effect of a perturbation in fission and absorption to reactivity. The problem of finding a fuel distribution $\psi(r)$ to maximize this expression was analytically formulated. A parameter study was made for the same reactors as for the uniform fuel distribution cases. This was done by shifting more fuel toward the center or toward the edge of the core. No gain in fissionable absorber sensitivity was observed for either the bare or the externally reflected cores. However, the internally and externally reflected core showed a 10% increase in fissionable absorber sensitivity when more fuel was shifted toward the center. (auth)

12494 THE INFLUENCE OF PRESSURE ON BOILING WATER REACTOR DYNAMIC BEHAVIOR AT ATMOSPHERIC PRESSURE. Joseph A. Fleck, Jr. (Univ. of California, Livermore). Nuclear Sci. and Eng., 9: 271-80 (Feb. 1961). (UCRL-5938-T)

Boiling-water-reactor dynamic behavior is most sensitive to pressure variations at atmospheric pressure due to the strong dependence of saturation temperature on pressure. The two important pressure variation effects at atmospheric pressure are the variation of hydrostatic pressure within the core, which leads to a change in saturation temperature with position, and the pressure variations resulting from the acceleration of water by changing steam volume. A system of equations that takes into account these pressure effects in a natural-circulation boiling-water reactor was derived by means of conservation principles stated in integral form. The resulting equations were solved numerically. Sample calculations revealed no special tendency toward instability other than a form of hydraulic instability that does not depend on the inclusion of pressure effects in the model. (auth)

12495 REACTIVITY EFFECT OF (n,2n) REACTIONS IN D_2O. H. K. Clark (E. I. duPont de Nemours and Co., Aiken, S. C.). Nuclear Sci. and Eng., 9: 282-3(Feb. 1961).

Multigroup calculations were made of an infinite sea of D_2O containing a uniformly distributed source of fission neutrons to determine not only the magnitude of the (n,2n) effect but also the effect of (n,α) and (n,p) reactions with oxygen. The effects were found approximately to cancel with a net loss of neutrons per fission neutron of 0.06%. (M.C.G.)

12496 FORMULAS FOR THERMAL REACTORS WITH SOME RESONANCE FISSION. P. F. Gast (General Electric Co., Richland, Wash.). Nuclear Sci. and Eng., 9: 283-4 (Feb. 1961).

In investigating the contribution of fissions induced by epithermal neutrons to the reactivity of thermal reactors, the following definitions are commonly used: $K_{thermal} = \epsilon\eta_t f P_{28} P_{25}$ and $K_{resonance} = \epsilon\eta_r P_{28}(1-P_{25})$, where P_{28} and P_{25} are the resonance escape probabilities for the fertile and fissile materials and the η's are the average thermal and resonance fissions. Formerly the total K was obtained by adding K_t and K_r, but it is shown that this is correct only in a very limited sense. A more general formulation of the form $K_{eff} = K_t/1 - k_r$ in those cases where $K_r < 1$ was derived. (M.C.G.)

12497 AEC'S PITTMAN REPORTS ON THE SL-1 ACCIDENT. Frank Pittman. Nucleonics 19: No. 3, 62-9 (Mar. 1961).

The facts pertinent to the SL-1 reactor accident of January 3, 1961 (9:01 p.m.), are reviewed, e.g., the reactor history, post-accident evidence, and radiation levels. It is tentatively postulated that movement of the central rod was the cause of the accident, although boron corrosion on the side plates with consequent poison loss could also have set off the accident; some of the possible causes of such rod movement are discussed. The operations involved in the connection of control rod drives (the operation that was being undertaken at the time of the accident) and the extent of burnable poison side plate damage are treated in detail. Part of the interim report of the Board of Inquiry regarding the possibility of the accident being initiated by central rod movement is presented. (D.L.C.)

12498 RADIATION LEVELS IN EBWR. Vincent C. Hall, Jr. and Robert H. Leyse (Argonne National Lab., Ill.). Nucleonics 19: No. 3, 80(Mar. 1961).

The radiation and contamination aspects of the Experimental Boiling Water Reactor, which has been under operation for 4 yr (8850 Mwd), are discussed. N^{16} accounts for >90% of the activity during operation, but only 0.1% of it enters the steam leaving the reactor vessel. Surface activity levels of major pieces of equipment both during operation and after shutdown are tabulated. The longer-lived radionuclides which result from neutron activation of corrosion products are discussed; Co^{58} is the major source of activity encountered in equipment maintenance after shutdown. In tests using Na^{24} tracer, 0.02% of the Na^{24} activity in the reactor water entered the steam and was carried to the external system. Corrosion products are deposited on the fuel plates until they flake off; however, no deterioration of the fuel plates due to heat transfer impairment by the deposit was observed at 0.37 at.% burn-up. Since the flakes settle in the areas with the control rod drive thimbles, the drives were redesigned with provision for flushing the flakes out of the system. (D.L.C.)

12499 N^{16} CONCENTRATION IN EBWR. Robert L. Mittl and Michel H. Theys (Argonne National Lab., Ill.). Nucleonics 19: No. 3, 81-3(Mar. 1961).

Less than 1% of N^{16} formed in the Experimental Boiling Water Reactor by O^{16}(n,p) reactions escapes into the steam, and maintenance of equipment within the containment vessel is not hindered. The mechanism of N^{16} production in the water and transfer to steam was studied by determining the proportions of anion, cation, and neutral N^{16} species, using ion exchange beds. The results show that, after its production, N^{16} combines mainly in an anion form which remains in the water and that the cation and neutral (but no anion) species are stripped from the water by steam. The anion/cation ratio for N^{16} species in water is 7 under normal conditions, whereas the neutral/cation ratio decreases with increasing reactor power. The effects of various additives on the anion/cation ratio were studied; N_2, O_2, and argon had no effect, whereas H_2, N_2H_4, and NH_3 decreased the anion/cation ratio in water and hence increased the steam activity. The effects of other factors,

e.g., reactor power, pressure, and water level, on the anion/cation ratio were also studied. (D.L.C.)

12500 REPAIR OF THE HRE-2 CORE. Eugene C. Hise and Irving Spiewak (Oak Ridge National Lab., Tenn.). Nucleonics 19: No. 3, 100, 102-3(Mar. 1961).

Two holes were formed in the Zircaloy core vessel connecting the core and blanket regions of the Homogeneous Reactor Experiment No. 2. A program was initiated to determine the cause of the damage and to develop repair methods. Flow tests made in a core model showed that solids could accumulate in regions of low velocity or flow separation, become overheated, and cause uranium to separate. This in turn would result in burn-out and a burned hole in the vessel. Core-wall cooling can be improved considerably by removing the five Zircaloy diffuser plates, reversing the flow direction, and finally patching the holes to stop core fluid from leaking into the blanket. Special equipment was developed for patching the holes remotely, e.g., periscope and associated lights, saws, etc. The procedures used in patching the holes are given. (D.L.C.)

12501 PRESSURIZED SUBCRITICAL FACILITY. E. J. Hennelly (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Nucleonics 19: No. 3, 104-5(Mar. 1961).

A pressurized subcritical facility using D_2O was constructed for collecting physics data for D_2O-moderated power reactor designs requiring high moderator temperatures. The facility has a self-pressurizing tank heated to 215°C by steam coils, and neutrons are supplied by five Sb–Be sources. The constructional details are given, e.g., of pressure vessel, neutron sources, fuel failure detector, foils for neutron flux measurement, and materials. (D.L.C.)

12502 NPR USES CARBON STEEL. H. R. Kosmata (General Electric Co., Richland, Wash.). Nucleonics 19: No. 3, 106, 108, 111, 112(Mar. 1961).

The New Production Reactor (NPR), under construction at Hanford, will be the first full-scale water-cooled reactor to use carbon steel for out-of-pile sections of the primary coolant loop. By replacing stainless with carbon steel, a saving of ~$10 million is estimated out of a total NPR cost of $145 million. Some of the reasons why stainless steel is presently used in most reactors are discussed, and the problems involved in the use of carbon steel (oxygen level, decontamination, etc.) are treated. (D.L.C.)

12503 NEUTRON SPECTRA IN HETEROGENEOUS PLATE REACTORS. II. Wolf Häfele (Kernforschungszentrum, Karlsruhe, Germany). Nukleonik 2: 240-6(Nov., 1960). (In German)

A generalization of the results of Hurwitz, Nelkin, and Habetler and of E. R. Cohen shows that the neutron spectrum of an infinitely large homogeneous reactor is given by utilization of the so-called heavy gas model. The generalization concerns the transition from infinite homogeneous media to finite heterogeneous plate reactors. It is possible to indicate the spectrum up to a given value of the absorption parameter of the fuel plates. (tr-auth)

12504 THE REACTIVITY EFFECT OF THE CAVITIES BETWEEN THE FISSION ZONE AND REFLECTOR ACCORDING TO THE P_L APPROXIMATION OF THE TRANSPORT EQUATION. D. Emendörfer and M. Ritzi (Technische Hochschule, Stuttgart, Germany). Nukleonik 2: 247-52(Nov. 1960). (In German)

The three-zone problem, fission zone-cavity-reflector, was solved for the spherically symmetric case by the P_1, P_3, and P_5 approximation of the monoenergetic transport equation. It is shown that the P_1 approximation represents sufficiently well the reactivity effect of cavities. A two-group theory was carried out solely within the framework of the P_1 approximation. The comparison of a transport theoretical P_L perturbation calculation with the rigorous P_L calculation shows that the perturbation calculation produces good results up to cavities with thickness S = 0.04 R (R is the radius of the fission zone). (tr-auth)

12505 EXACT MULTI-GROUP DIFFUSION THEORY OF THE FINITE HETEROGENEOUSLY CHARGED REACTOR. W. Oldekop (Siemens-Schuckertwerke AG, Erlangen, Germany). Nukleonik 2: 252-4(Nov. 1960). (In German)

It is shown that the general solution for a finite heterogeneous reactor with plate-like fuel elements (one-dimensional problem) is of the form, for $\underline{n}$ energy groups, $\vec{\Phi}(x) = \sum_{k=1}^{n} [\gamma_k^+ \vec{\varphi}_k^+(x) \cdot e^{+\lambda_k x} + \gamma_k^- \cdot \vec{\varphi}_k^-(x) \cdot e^{-\lambda_k x}]$, where γ represents arbitrary constants and $\vec{\varphi}$ (x), elementary analytical calculable lattice periodic reactor fluxes; the characteristic flux buckling λ_k^2 is given as accurately as in homogeneous reactors from an algebraic equation of $\underline{n}$ degrees. The critical condition for a bare reactor consisting of an odd number of cells is as accurately as in the homogeneous case, $\lambda_0/i = \pi/L$, where L is the length of the system and λ_0 is the imaginary root of the characteristic equation. (tr-auth)

12506 BASIC PRINCIPLES OF FISSION REACTORS. W. R. Harper. New York, Interscience Publishers Inc., 1961. 319p. $7.50.

An introduction to reactors is presented assuming only a background of physics and mathematics and no previous knowledge of nuclear technology. The mathematical treatments are chosen to clarify basic principles. Reactors of historical importance are described. Some of the topics treated are the West Stands Experiment, power reactors, fuel elements, fast reactors, moderators, homogeneous and heterogeneous reactors, control of radioactivity, radiation protection, removal of heat, and reactor operation. (D.L.C.)

12507 DIRECTORY OF NUCLEAR REACTORS. VOLUME III. RESEARCH, TEST AND EXPERIMENTAL REACTORS. (Supplement to Volume II). (International Atomic Energy Agency, Vienna). 1960. 362p. (STI/PUB/22)

This volume is a continuation of the second volume issued in November 1959 in which details of research were assembled and analyzed. Information is presented in two ways. For those reactors having little similarity with any other reactor, full details are given, including general information, reactor physics data, information on core and fuel elements, sketches of reactor and fuel element assembly, core heat transfer, control, reactor vessel and overall dimensions, reflector and shielding, containment, cost estimate, research and experimental facilities, and information on fluid flow. For the remaining reactors having great similarity to these described in full detail, general information and major modifications are presented. The reactors are grouped under the following headings: light-water-moderated, pool-type research reactors; light-water-moderated, tank-type research reactors; liquid-homogeneous research reactors; solid-homogeneous research reactors; heavy-water-moderated research reactors; graphite-moderated research reactors; and fast research reactors. Conversion tables and nomograms are also included. (M.C.G.)

12508 NUCLEAR SAFETY. Technical Progress Review, Vol. 2, No. 2. W. B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Dec. 1960. 94p.

Topics relevant to the analysis and control of hazards associated with nuclear reactors, operations involving fis-

sile materials, and the products of fission are discussed. Primary emphasis is on safety in reactor design, construction, and operation. Reviews are included of safety practices in European countries, accidents involving chemical reactions of liquid fuels or liquid coolants, methods of monitoring gaseous wastes, applications of statistical analysis in predicting the reliability of reactor safety devices, plant safety features, the consequences of activity release, and recent developments in reactor operations. (C.H.)

12509 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Metallgesellschaft Aktiengesellschaft). British Patent 855,155. Nov. 30, 1960.

A reactor is designed in which enriched gaseous UF_6 is heated by fission and then expanded to perform work. The reactor is comprised of a core defining a turbine housing with a turbine rotor. Expansion of the UF_6 gas after nuclear reaction prevents reactor overheating. Some of the materials suitable for construction of such a reactor are discussed. An embodiment of this reactor giving 10 Mw is described. (D.L.C.)

12510 PUSH-PULL TANDEM NUCLEAR REACTOR USING A LIQUID FUEL. (to U. S. Atomic Energy Commission). British Patent 855,671. Dec. 7, 1960.

A homogeneous reactor system is designed which utilizes a new method for circulating the liquid fuel through a heat exchanger. The reactor system consists of two reactors connected to each other through a heat exchanger, and each reactor contains a critical region and a vapor region. When the liquid in the first critical region becomes critical, its temperature rises, leading to an increased vapor pressure which forces the liquid out through the heat exchanger into the second critical region. This situation is repeated in the second critical region. (D.L.C.)

12511 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. William George Edgar Wood (to A.E.I.-John Thomson Nuclear Energy Co., Ltd.). British Patent 858,383. Jan. 11, 1961.

A graphite core structure for graphite-moderated gas-cooled reactors is designed in which compensation for Wigner growth is made with lower gas leakage than in previous designs. The core is comprised of graphite blocks arranged in vertical stacks with their grain vertical and graphite slab pairs interposed between adjacent stacks and with the grain horizontal in mutually perpendicular directions. The slabs are offset horizontally from the fuel passages so that leakage is avoided. (D.L.C.)

12512 IMPROVEMENTS RELATING TO NUCLEAR REACTORS AND IN THE OPERATION THEREOF. Anthony James Taylor (to Babcock and Wilcox, Ltd.). British Patent 858,504. Jan. 11, 1961.

A graphite-moderated reactor is designed with its cooling system so arranged that the upper fuel-element temperature limit is achieved in all channels. This achievement is obtained by means of gages in the outer channels and division of the coolant path into three paths using windboxes. Since the coolant from the outer channels under these conditions is usually hotter than the coolant from the inner channels, it may with advantage be passed into a second heat exchanger before passing into the main heat exchanger. (D.L.C.)

12513 EQUIPMENT FOR DISTRIBUTING GASEOUS OR LIQUID MEDIA IN FLUIDISED REACTORS. (to Metallgesellschaft, A. G.). British Patent 858,613. Jan. 11, 1961.

Equipment is described for the uniform introduction of gases, vapors, and liquids into a fluidized bed of fine-grained solids in a reactor. The equipment consists of straight tubes with a large number of round or elongated openings through which the media enter the bed; the tubes are inserted into the reactor through short pipe sections built into the wall. The advantage of these tubes is that each of the tubes can be separately withdrawn, checked, and replaced when necessary. (D.L.C.)

12514 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. (to Babcock and Wilcox Co.). British Patent 858,624. Jan. 11, 1961.

A process for fabrication of plate assembly type fuel elements is given which solves the problems of cladding material corrosion, fabrication of hard nonannealed materials, and warpage during fabrication. This process simply consists of bending or otherwise deforming the edges of the fuel plates so that, when they are inserted into the grooves of the side plates, friction between the edges and grooves holds the plates in place. In this way, the need for brazing and its associated problems are avoided. (D.L.C.)

12515 IMPROVEMENTS IN OR RELATING TO NUCLEAR GRAPHITE MODERATOR STRUCTURES. (to Showa Denko Kabushiki Kaisha). British Patent 860,398 Feb. 1, 1961.

A reactor graphite moderator is designed in which internal stresses from temperature changes or Wigner growth are minimized, deformation is reduced, and gaseous coolant leakage from coolant channels is prevented. The moderator is comprised of layers of extruded vertical graphite blocks with layers of molded graphite tiles separating the ends of the blocks in adjacent layers; the blocks have axial cylindrical coolant channels, while the tiles are arranged so that their centers coincide vertically with the coolant channels, notches being provided at the tile corners to fit the channels. Keys and keyways are provided on both blocks and tiles to fit them together. A small gap is left between adjacent blocks for Wigner growth, but the tiles prevent coolant leakage or neutron streaming. (D.L.C.)

12516 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Clive Frederick George Dupen (to AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 861,222. Feb. 15, 1961.

Fuel rods containing UO_2 canned with beryllium, zirconium, or stainless steel can be fabricated with voids in which fission gases can accumulate without bursting the can. The voids may be in the form of a central hole in the fuel or of a space between the fuel and the can plug. An advantage of the central hole arrangement is the reduction of the center temperature for one-heat output. (D.L.C.)

12517 IMPROVEMENTS IN AND RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Graham Coates and Clive Frederick George Dupen (to AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 861,329. Feb. 16, 1961.

A reactor fuel element assembly is designed which has the advantage of an increased external surface area per volume of fissile material together with structure strength. The assembly comprises a central vertical pillar with a spider support assembly at the top which supports a fuel rod array and with a perforated bottom plate that locates the fuel rods with mating surfaces while allowing them to expand downwards. This assembly design is applicable to gas-cooled graphite-moderated reactors and possibly to liquid-cooled reactors. The fuel rods which are to be used with the assembly are described in Patent No. 861,222. (D.L.C.)

Power Reactors

12518 (ACNP-6012) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, JULY 1960–SEPTEMBER 1960. (Allis Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Jan. 5, 1961. 176p. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589.

Technical progress on the research and development program being performed in connection with the design of the Sioux Falls Power Reactor is reported. Areas covered include fuel-material cladding, bonding, and irradiation testing; heat-transfer and fluid-flow studies; fuel-element manufacturing research and development; construction of nuclear handling tools; design of a low-enrichment superheater fuel element; vessel, structure, recirculation system, and control rod studies; analyses of reactor and system dynamics and critical experiments; and initial stability and performance tests. (For preceding period see ACNP-6007.) (M.C.G.)

12519 (AE-31) CALCULATION OF THE REACTIVITY EQUIVALENCE OF CONTROL RODS IN THE SECOND CHARGE OF THE HBWR. P. Weissglas (Aktiebolaget Atomenergi, Stockholm). Sept. 1960. 21p.

Using current methods the reactivity equivalence of 19, 31, and 37 centrally located control rods in the second charge of the HBWR was calculated. An estimate of the available excess reactivity with clean cold core was also made. Insertion depth was taken as 0, $\frac{1}{3}$, $\frac{2}{3}$ and $\frac{3}{3}$ of the core length. (auth)

12520 (AECU-4494) SIMULATION OF A CONTROL SYSTEM FOR A MERCHANT-SHIP PRESSURIZED-WATER REACTOR. Roger S. Boyd, Richard H. Byers, and Benjamin B. Gordon (Battelle Memorial Inst., Columbus, Ohio). Jan. 14, 1958. 95p. For Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. (BMI-B&W-639)

A control system for a pressurized-water reactor for use in a nuclear-powered merchant ship was studied by use of analog simulation techniques. The various components of the reactor and primary-coolant loop, including the boiler, were considered. Each simulated component was examined separately and then coupled into the system. With the existence of a large Doppler coefficient of reactivity, the average system temperature could not be maintained within the required limits without external control. Control of the reactor plant through use of a shim-rod mechanism was proposed. Two control schemes were considered. The first system involved control by means of a temperature-error signal and a power-demand signal. The second consisted of a closed reactor-loop system. A power-error signal was generated by comparing reactor power with a signal proportional to steam flow plus the error in average system temperature and integral of this temperature error. The first system produced acceptable results for only specific conditions. The closed-loop system satisfied the criteria for plant control; for this control system to be entirely acceptable, the maneuverability requirements must be made compatible with the allowable control-rod reactivity rates. The maximum rates needed for control under a given steam-load-demand change were established. (auth)

12521 (AGN-TM-384) THERMO-ELASTIC ANALYSIS OF THE ML-1 TUBE SHEET AND PLENUM CHAMBER. Army Gas-Cooled Reactor Systems Program. E. M. Corbin (Aerojet-General Nucleonics, San Ramon, Calif.). Feb. 1961. Contract AT(10-1)-880. 65p.

Analytical results are presented of the stress distribution of the ML-1 reactor's tube sheets and its cylindrical plenum chambers. The gas pressure in the assembly was 330 psi, and the moderator water pressure was taken at 30 psi. The tube sheets designed with internal cooling channels had a maximum temperature of 340°F. The stresses found in the tube sheet and plenum cylinder were satisfactory and below the allowable yield strength at temperature. The maximum stress found at the center of the perforated tube sheet was 17,226 psi. Stresses in the interconnecting tubes were also below the allowable limit. The maximum fiber stress in the tube was 16,629 psi. The margin of safety in the tubes, although satisfactory, was not as ample as in the tube sheet and plenum assembly. In addition to stresses, other elastic quantities are given in tabular and graphical form. (auth)

12522 (ANL-6266) INSTABILITY STUDIES WITH EBR-I, MARK III. R. R. Smith, J. F. Boland, F. D. McGinnis, M. Novick, and F. W. Thalgott (Argonne National Lab., Ill.). Dec. 1960. 92p. Contract W-31-109-eng-38.

The results of instability studies suggest that the operational characteristics of the fully ribbed and rigid Mark III loading are governed by feedback processes that guarantee safe and stable operation under normal operating conditions. No evidence of positive reactivity effects was noted for the fully-ribbed rigid core. Logical extrapolations of full-power full-flow test data indicate that the reactor could be brought into a resonant condition for power levels exceeding 1000 Mw. Strong nonlinearities were observed in power coefficients and were considered to pose no serious operational problems above 200 kw in the power range associated with the tests. An application of the Nyquist stability criterion to the extrapolated fully sheared data results in the conclusion that the reactor would attain resonance instability at full flow at ~11 Mw. Logical extrapolations of test data for one-third flow results in resonance instability at ~10 Mw, a power level ~20 times that designed for one-third flow. Rib shearing was shown to result in an unexpected and unexplained increase in the magnitude of the delayed structural power coefficient component. An empirical fit of feedback data to a model describing the dynamic and static behavior of the partially sheared core resulted in the values for the respective prompt negative, rod-bowing, and delayed structural power coefficient components of -2.21×10^{-6}, $+0.543 \times 10^{-6}$, and -0.873×10^{-6} $\Delta k/k/kw$. The overall behavior of the Mark III core, whether fully ribbed and rigid, fully ribbed and loose, or even partially or fully sheared, is one of extreme stability. The inclusion of stabilizing ribs and a system of tightening rods in the Mark III design eliminated, or at least reduced to a point beyond detection, the prompt positive rod-bowing component that existed in the Mark II. (B.O.G.)

12523 (APAE-Memo-266) DEVELOPMENT AND DESIGN STUDIES OF SM-2 PRESSURIZER. P. L. Bradley (Alco Products, Inc., Schenectady, N. Y.). July 29, 1960. 49p. Contract DA-44-192-ENG-7. (AD-241340)

Comparisons to SM-1 plant performance indicated that the computer model previously used to determine pressurizer performance and select the proper size was significantly in error in treating loss of load transients because it failed to account for the condensation which automatically takes place on the vessel wall and liquid interface. This also made the model incapable of evaluating methods of augmenting this condensation. The most appropriate condensation rates that could be arrived at from the literature were selected, and the analog computer model revised and greatly augmented to incorporate this phenomenon. Using this model, a generalized curve was derived for sizing a pressurizer for the SM-2 or similar PWR plants. The new model was also used to evaluate

some new design concepts, one of which appears very worthwhile for large pressurizers, or whatever size is particularly critical. If automatic pressure-regulated sprays or standpipe are provided, the total space required between minimum and maximum pressures due to positive and negative load transients can be further reduced by making the target steady-state pressure a function of steam generator load, with the no-load level approximately 100 psi higher than the full-load pressure. (auth)

12524 (APAE-Memo-269) TRANSIENT ANALYSIS OF A PRIMARY LOOP WITH A TWO-PASS CORE BY ANALOG COMPUTER METHODS. J. O. Brondel (Alco Products, Inc., Schenectady, N. Y.). Aug. 19, 1960. 55p. Contract DA-44-192-ENG-7. (AD-242781)

A kinetic model of the primary loop of the SM-2 reactor plant is developed to evaluate, by analog computer techniques, the transient response characteristics due to steam-generator load and reactor-control-rod perturbations. The SM-2 model presented an extension of the basic pressurized water model developed previously, and it features a two-pass core with an additional transport delay between passes. The analysis includes recognition of a separate temperature coefficient of reactivity for each pass. Computer circuits and potentiometer settings are presented in both symbol form and in scaled form to correspond with the SM-2 final design configuration. Although the model was developed for evaluation of SM-2 primary transients, it is generally applicable to two-pass cores of the pressurized water type. (auth)

12525 (APAE-Memo-280) ACTIVITY BUILD-UP CONTROL BY HIGH pH COOLANT. A LITERATURE SURVEY. C. R. Bergen (Alco products, Inc., Schenectady, N. Y.). Jan. 23, 1961. 14p. Contract AT(30-1)-2639.

A survey was made of unclassified literature dealing with the control of activity build-up in pressurized water reactors by high-pH coolants. Survey results indicate that a high-pH coolant is desirable for control of induced radioactivity build-up in pressurized water reactors containing significant amounts of stainless steel and that no significant hazards are introduced by adoption of a high-pH coolant. Lithium hydroxide was found to be the most acceptable agent for coolant pH control. Strong-base-form mixed-bed resin is effective in maintaining both coolant pH and coolant purity. (auth)

12526 (CEA-1659) REACTEURS NUCLEAIRES. (Nuclear Reactors). M. B. Leo (France. Electricite de France, Paris) and M. L. Maillard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 21p.

The first French plutonium-making reactors G1, G2, and G3, built at Marcoule Research Center, are linked to a power plant. The G1 electrical output does not offset the energy needed for operating this reactor. On the contrary, reactors G2 and G3 will each generate a net power of 25 to 30 Mw, which will go into the EDF grid. This power is relatively small, but the information obtained from operation is great and will be helpful for starting up the power reactors EDF1, EDF2, and EDF3. The paper describes how, previous to any starting-up operation, the tests performed, especially those concerned with the power plant and the pressure vessel, have helped to bring the commissioning date closer. (auth)

12527 (CEA-1660) LES CENTRALES NUCLEAIRES DE PUISSANCE DU PROGRAMME FRANÇAIS. (The Nuclear Power Stations of the French Atomic Energy Programme). C. Leduc (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay) and J. P. Roux (France. Electricité de France, Paris). 1960. 25p.

After recalling the entry of nuclear energy into energy production in France, the paper emphasizes the evolution of techniques applied in the designing of French nuclear power plants and describes the means employed for reducing costs per kwh of EDF2 and EDF3 compared with EDF1: the electric power per ton of uranium varies from 493 kw/ton for EDF1 to 970 kw/ton for EDF3. For this purpose the thermal and electric power of units are changed, respectively, from 290 Mw(t) for EDF1 to 1200 or 1600 Mw(t) for EDF3 and from 28 to 250 Mw. The results are obtained by an improvement in neutronic characteristics, developments in nuclear fuel technology, and simplification of the system of charging the reactor, with an increased means of maintenance; the EDF2 heat-exchangers have been so designed as to increase the unit power of the elements, which will attain 9 Mw(t), as against 3 for EDF1. For EDF3 an advance project forecasts a thermodynamic layout with only one pressure stage. A description is given of the burst-slug detection systems, and an appendix gives a detailed comparative table of EDF1, EDF2, and EDF3 plant characteristics. (auth)

12528 (CF-60-12-49) ANALOG COMPUTER ANALYSIS OF THE THERMAL BEHAVIOR OF THE EGCR DUE TO REACTIVITY ACCIDENTS. R. M. Pierce (Oak Ridge National Lab., Tenn.). Dec. 16, 1960. 17p.

The ORNL analog computer was used to examine one aspect of a safety system for the EGCR. The thermal behavior of the fuel, as a result of increases in reactivity at various power levels and gas flows, was examined. Safety actions initiated by either a flux-minus-flow signal or a reactor outlet gas temperature signal were included in the simulation. (auth)

12529 (CVNA-52) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. QUARTERLY PROGRESS REPORT FOR THE PERIOD JANUARY 1, 1960 TO MARCH 31, 1960. P. G. De Huff (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). May 1960. 194p.

An IBM-704 computer program, HYDNA, is being developed to investigate the transient behavior of the coolant in parallel channels (pressure tubes) in a closed-channel reactor. Studies were made to determine the effect of reflector thickness on the nuclear and thermal performance of the core. These studies indicated that the reflector thickness could be reduced by 6 in. with only minor effect on the hot-channel factor and fuel burn-up. The Phase I pressure tube–fuel assembly tests were started. The results to date have indicated that the heat losses are higher than anticipated. Two Marman Conoseal fittings were tested in the thermal cycling loop; one a refueling port mock-up and the other a test model of the upper in-pile Zircaloy to 410 stainless-steel transition joint. Both joints performed very well. The jumper tube orifice tests continued. The tests have indicated that a double orifice plate should be tested since it offers promise for reducing erosion. The studies to determine the degree of coolant mixing in the fuel assemblies were continued. The effort is being concentrated on the 12- and 15-in. spacer wire pitches. The test equipment for the measurements of thermal contact resistance between the fuel pellet and clad was designed. After a study of the various control rod drive systems, the decision was made to use a top-mounted gravity-scramming rack-and-pinion drive type for CVTR. Efforts to obtain a satisfactory method for permanently affixing spacer wires to the fuel-element cladding were increased. Three methods are being considered: welding or brazing of wire to the cladding or extrusion of cladding with an integral fin. Studies

were begun on the preoxidation treatment of Zircaloy. In this process, the Zircaloy is preoxidized in an oxygen atmosphere rather than in steam or water with the purpose of reducing hydrogen pickup. Considerable effort was expended in establishing over-all reactor layouts, incorporating the latest features of the various component designs. A major change, wherein the moderator tank diameter was reduced by 1 ft and the tank suspended from its top, was made. A proposed reduction in primary coolant system design pressure was effected lowering the value from 1800 to 1730 psia. A final conceptual layout of primary coolant system was prepared and integrated into over-all plant design. (For preceding period see CVNA-45.) (auth)

12530 (CVNA-57) STEAM GENERATOR HEAVY WATER LEAKAGE STUDY. CAROLINAS-VIRGINIA TUBE REACTOR. W. R. Snyder (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). June 16, 1960. 23p.

A detailed study of the heavy-water-loss problems associated with steam-generator leakage was made. A model of the secondary system was defined and analyzed to determine the magnitudes of the heavy-water losses that could result from steam-generator leaks of various magnitudes. The results of the study are given. Actual types of leaks that may occur and the probabilities of their occurrence are not treated. Also excluded are attempts at correlation between hole geometries and leak rates. (auth)

12531 (DLCS-1490109) CONTROL ROD POSITIONS FOR CRITICALITY. CORE 1, SEED 1, 5532.3 EFPH. Section 1. Test Results T-550130. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 7, 1960. 15p.

Critical bank heights and bank worths for various rod configurations at ambient temperature were determined and are presented. (W.L.H.)

12532 (DLCS-1490110) CONTROL ROD POSITIONS FOR CRITICALITY O EFPH. CORE 1, SEED 2. Test Results T-550130. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 2, 1960. 13p.

The critical bank heights and worths were determined for various rod configurations at ambient temperature. Results are reported. (W.L.H.)

12533 (DLCS-1560108) XENON TRANSIENT, 761.3 EFPH. CORE I, SEED 2. Section 1. Test Results T-612081. (Duquesne Light Co., Shippingport, Penna.). First issue, Dec. 9, 1960. 45p.

Tests were conducted to determine if there is sufficient excess reactivity in the Shippingport PWR to override a peak xenon transient and to obtain data for rod worth calculations. Upon completion of 761.3 EFPH of operation on core I, Seed 2, there was sufficient excess reactivity in the core to override the peak xenon transient which occurred 9 hr after station shutdown. At that time the controlling rod group (group II) was at a height of 38.43 in., while group-I rods were fully withdrawn and group-III and -IV rods were fully inserted. The rod worth values for the group-II rods decreased with increasing EFPH for Core I, Seed 2, for the first 20 in. of rod withdrawal. (J.R.D.)

12534 (DLCS-1840205) PERIODIC RADIATION SURVEY OF REACTOR PLANT CONTAINER AND COMPONENTS AFTER SHUTDOWN, "I" SURVEY. CORE 1, SEED 1. Section 2. Test Results T-612076. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 17, 1960. 21p.

The radiation level and its decay were measured at expected hot-spots in the reactor container, 1AC and 1BD boiler containers, and pressurizer cubicle after plant shutdown for refueling. Initial measurements indicated relatively high radiation levels in certain areas. Maximum initial readings were 500 mr/hr, 400 mr/hr, 530 mr/hr, and 195 mr/hr in the reactor container, 1AC boiler container, 1BD boiler container, and purification cubicle, respectively. (W.L.H.)

12535 (DLCS-2130101) MODIFIED PURIFICATION SYSTEM PERFORMANCE TEST. CORE 1, SEED 1. Test Results T-641124. (Duquesne Light Co., Shippingport, Penna.). First issue, July 16, 1960. 24p.

A test was made to determine the over-all effects of reduced coolant purification on the reactor plant. The effects were increased specific activity, gross γ activity, and fission product activity of the reactor cooling system. (W.L.H.)

12536 (DLCS-2200101) MEASUREMENTS OF DISSOLVED HYDROGEN CONCENTRATION. CORE I, SEED 1. Test Results T-612395-A. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 17, 1960. 15p.

Measurements were undertaken to compare the performance of a hydrogen-palladium diffusion coil to a palladium resistance wire assembly in measuring hydrogen concentration and to obtain data to evaluate a Swartout Palladium Resistance Gage electronic readout unit. No comparison could be made since the instruments were never in satisfactory service at the same time. The data taken with each instrument are compared with data determined by laboratory analysis. A review of the data indicated that the units were unreliable. (B.O.G.)

12537 (DLCS-2290101) COMPARISON OF FEDAL MONITOR READINGS WITH RADIOCHEMICAL SAMPLE DATA. CORE I, SEED 1. Test Results T-641305. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 24, 1960. 13p.

Tests were conducted to compare the specific isotopic fission product activities with those of delayed neutron emitters which are monitored by the FEDAL System, and to obtain information on the source of activity observed in the PWR coolant. The monitors detected definite activity bursts of delayed neutrons during load increases, which indicated a rupture of the core blanket element. A radiochemical analysis of the coolant data did not show any unusual activity bursts, thus indicating a fuel element failure. It was concluded that the discrepancy in measurements is caused by methods not specifying exactly the time for taking radiochemical samples. The data are tabulated as activity and power output, and given as a function of time. A comparison is given of the activities in the primary coolant for April, June, and July of 1958. (B.O.G.)

12538 (DLCS-2340105) RADIATION LEVELS IN THE VICINITY OF THE PURIFICATION DEMINERALIZERS. CORE 1, SEED 1. Test Results T-641306. (Duquesne Light Co., Shippingport, Penna.). First Issue, Oct. 10, 1960. 12p.

A test was performed to determine the activity build-up inside the 1AC and 1BD purification demineralizer concrete enclosure. A maximum radiation level of 1100 mr/hr was detected inside the 1AC demineralizer enclosure at a point 10.0 ft from the top. The maximum radiation level inside the 1BD enclosure was 700 mr/hr at a point 9.5 ft below the top. An analysis of data from five tests indicates that the extent of the activity build-up, as well as the level of activity, is definitely increasing. (W.L.H.)

12539 (DLCS-2410202) NON-DESTRUCTIVE TESTING OF STAINLESS-CARBON STEEL WELDS. CORE I, SEED 2. Section 2. Test Results T-641300. (Duquesne Light Co., Shippingport, Penna.). First issue Jan. 10, 1961. 14p.

Results are presented which lead to the conclusion that

all the welds that were radiographed appear to be satisfactory for continued use in the plant except in the 1A reactor coolant loop drain weld. The radiograph of this weld indicates the presence of a $\frac{3}{8}$ in. transverse defect. The majority of the welds showed indications of porosity. (J.R.D.)

12540 (DLCS-2430103) PERIODIC CALIBRATION OF TEMPERATURE SENSING ELEMENTS. CORE 1, SEED 1. Test Results T-641303. (Duquesne Light Co., Shippingport, Penna.). First issue May 29, 1960. 32p.

A test was made to determine the direction and magnitude of any drift in the temperature-sensing elements and the receiver-indicating units for the reactor coolant loop and pressurizer resistance thermometers. A test was also made to determine the difference between the measured value of the neutron flux with the reactor shut down, as determined by BF_3 counters, and the neutron flux due to the Po–Be source. (W.L.H.)

12541 (DLCS-3210101) REFUELING–CORE I, SEED 1–DISASSEMBLY INSPECTION OF CONTROL ROD DRIVE MECHANISMS. Test Results T-643711. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 18, 1960. 20p.

An inspection was made of the drive mechanisms for corrosion, crud, pitting, and activity. Localized crud deposits were found in the L-5, F-12, and H-4 damper guide cup washers. Corrosion and pitting appeared slight. The γ radiation level of the components ranged from 1 to 1900 mr/hr. Smear samples of the components indicated relatively low activity levels–the highest being 140 mr/hr, γ. The γ emission spectrum for each smear sample showed the composition of all samples to be identical, from Fe^{59}, Co^{60}, Mn^{54}, Cr^{51}, Hf^{181}, and Zr^{95}. The specific activity was highest for Co^{60} (1.90×10^7 dpm/mg) and lowest for Zr^{95} (2.20×10^4 dpm/mg). (B.O.G.)

12542 (DLCS-3220101) RADIATION SURVEY OF SIX OF THE THERMAL BARRIERS. CORE 1, SEED 1. Test Results T-643713. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 11, 1960. 10p.

A test was performed to determine the radiation levels of the thermal barriers contained in the rod-drive-mechanism housings. Of the six thermal barriers examined, the two-slot type instrumented barriers exhibited higher radiation levels (350 to 2450 mr/hr) than did either the plain type instrumented barrier (1350 mr/hr) or the three noninstrumented barriers (275 to 725 mr/hr). (W.L.H.)

12543 (DLCS-3280101) HYDROGEN DISTRIBUTION AND LEAK RATE FROM THE REACTOR COOLANT SYSTEM. Test Results, RNI-31 A. Core I, Seed 1. (Duquesne Light Co., Shippingport, Penna.). First issue, June 9, 1960. 8p.

No conclusions could be made concerning the distribution of hydrogen injected into the reactor coolant because the samples were taken only from the purification loop through which the hydrogen was added. No comparison of the uniformity of distribution obtained by injecting hydrogen through either the AC or the BD purification loop could be made. Comparative data were not taken until 9 days had elapsed since injecting hydrogen and the concentration was near the lower limit (15 cc/kg). The rates of hydrogen loss during the test were 5.9 cc/kg/day for hydrogen injected through the AC purification loop, and 4.1 cc/kg/day for hydrogen injected through the BD purification loop. (auth)

12544 (DLCS-3410101) EXTERNAL RADIATION LEVELS OF REACTOR COOLANT LOOP PIPING. CORE 1, SEED 2. Test Results T-612076-A. (Duquesne Light Co., Shippingport, Penna.). First Issue, June 1, 1960. 11p.

A test was made to establish an initial base level of external radiation in coolant-loop piping and components prior to start-up. This data, when compared with future tests, will yield information on the build-up of corrosion product activity. (W.L.H.)

12545 (DLCS-3440101) RAPID STATION SHUTDOWN. CORE 1, SEED 2. Test Results T-643729. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 4, 1960. 14p.

A test was made to determine the dynamic response of the reactor plant to a rapid station shutdown and to prepare the station for low-power physics testing. The reactor plant sustained a complete loss of station load at an average of 0.85 Mw/sec, using pressurizer spray, manual rod insertion, and the decay heat removal system to control the transient. The highest temperature recorded during the transient was a T_h of 521°F on the 1A loop 2.5 min after initiation of the shutdown. (W.L.H.)

12546 (DLCS-3600101) FLOW COASTDOWN TEST. CORE I, SEED 2. Test Results T-612087-A. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 10, 1961. 24p.

Results of tests to determine the flow coastdown characteristics in the Shippingport Reactor are presented for various loss-of-flow accidents. It is concluded that the characteristics are in close agreement with the design predictions. The flow, for a complete loss of flow accident, is slightly greater than the predicted flow during the coastdown for the first few seconds after loss of pump power. The flow for sequential loss-of-flow accident is slightly less than the predicted flow during the coastdown for about two seconds after loss of the first pump. (J.R.D.)

12547 (DP-565) HEAVY WATER MODERATED POWER REACTORS. Progress Report, November 1960. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Feb. 1961. 40p. Contract AT(07-2)-1.

Construction of the Heavy Water Components Test Reactor is 45% complete. The leakage rate in a pneumatic test of the containment building was 0.56% per day of the building air at an internal pressure of 23.3 psig. Buckling experiments were conducted in D_2O at a maximum temperature of 217°C on 19-rod clusters of Zircaloy-clad UO_2 pellets intended for use in a Swedish power reactor, the R-3/Adam. The measurements are in agreement with Swedish predictions. Buckling measurements with full-scale lattices of UO_2 rod clusters in D_2O were started in the Process Development Pile. Postirradiation examination of three coextruded tubes of Zircaloy-clad uranium–2 wt.% zirconium which failed during earlier irradiation tests at Savannah River, indicated that two of the failures were probably caused by fractures originating within the cores and that the third was caused by a cladding defect. (For preceding period see DP-555.) (auth)

12548 (GA-1470) NUCLEAR SHIP ECONOMICS. Tom B. Pearson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 7, 1960. Contract AT(04-3)-187. 38p.

A discussion is presented which touches briefly on a few of the major considerations involved in an economic evaluation of nuclear power for ships. (W.L.H.)

12549 (GA-1515) APPLICATION OF HIGH-TEMPERATURE GAS-COOLING TO NUCLEAR POWER PLANTS, THE HTGR. Frederic de Hoffmann and Peter Fortescue (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 6, 1960. 12p.

For Presentation at the International Atomic Energy Agency Conference on Small and Medium Power Reactors, Vienna, September 5-9, 1960.

A detailed description is given of the Peach Bottom Power Reactor plant and components. (W.L.H.)

12550 (GA-1516) MGCR AS A LAND-BASED ELECTRIC PLANT. A BERYLLIUM–OXIDE MODERATED, GAS-COOLED REACTOR. Frederic de Hoffmann and William T. Furgerson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 6, 1960. 15p.

For Presentation at the International Atomic Energy Agency Conference on Small and Medium Power Reactors, Vienna, September 5-9, 1960.

The suitability of the Maritime Gas Cooled Reactor (MGCR) for small and medium-sized land-based power plants is discussed. The design features of the reactor are summarized. It was estimated that a small central-station power plant of this type could produce 23 Mw at an estimated unit cost of 14.4 mills/kw-hr. Construction of a 10-Mw test reactor that will be beryllium oxide moderated and helium-cooled is planned. Heat generated in the reactor will be removed into a heat dump without generating any power. This facility will be used to obtain information on the performance of fuel elements, moderator, and control rods. (M.C.G.)

12551 (GAMD-1007) ECONOMIC STUDIES OF VARIOUS MARINE NUCLEAR POWER PLANTS. B. A. Engholm and R. C. Potter (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 29, 1959. 49p. (MGCR-R-159)

Capital, fuel-cycle, and system costs are computed for the Boiling Water Reactor, Organic-Moderated Reactor, and Maritime Gas-Cooled Reactor power plants. Comparisons are made for power rating of 30,000 SHP for the 1965 and 1970 time periods. The principal results are tabulated, assuming a plutonium credit of $30/g in 1965 and $12/g in 1970. (auth)

12552 (GAMD-1078) APPROXIMATE SURFACE TEMPERATURES IN MGCR CORE AFTER LOSS OF COOLANT. G. B. Webb (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 28, 1959. 10p. Contract AT(04-3)-187. (MGCR-RPE-63; MA-S89-1).

Approximate surface temperatures in the center of the prototype MGCR core after loss of coolant were calculated assuming equilibrium radiant transfer of heat from fuel to moderator and no loss or gain of heat from a unit fuel-moderator cell. Results and method of calculation are given. (W.L.H.)

12553 (GAMD-1207) PRELIMINARY COMPARISON OF URANIUM AND THORIUM FUELING FOR BeO REACTOR. T. H. Pigford and E. A. Mason (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 29, 1960. 22p. Contract AT(04-3)-187.

Results are reported of a study made to develop a preliminary estimate of the relative economics of U^{235}–Th and U^{235}–U^{238} fueling for a BeO-moderated MGCR. The two basic cases used to obtain the nonleakage probabilities were (1) the uranium system, which contains 207.7-kg U^{235} at 5% enrichment and which corresponds to an optimum enrichment and (2) the thorium system, which contains 207.7-kg U^{235} at 93.4% enrichment and 3486-kg of thorium as ThO_2. Effects of a possible reduction in neutron age and a likely increase in gross fission-product cross section are considered. Burn-up calculations and cost estimates were made for the case of no stainless steel in the core, which were used to indicate the economics of possible unclad or ceramic-clad MGCR cores. Tabulated results include the following: reactor-core and fuel-element description, effective thermal cross sections, core composition and relative thermal flux, integral nuclear data for uranium and thorium basic designs, neutron balances for cases 1 and 2, unit cost assumptions, and calculated results. The core life is given as a function of initial fuel enrichment for clad and unclad fuel. (B.O.G.)

12554 (GAMD-1416) OVERALL REACTOR HEAT TRANSFER COEFFICIENTS FOR TRANSIENT ANALYSIS. W. I. Thompson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 6, 1960. 10p. Contract AT(04-3)187. Project No. 40. (MGCR-R-239)

A Fortran computer program is described for dynamic analysis of the complete MGCR power plant. The program includes descriptions of all major power-plant components and estimates of the thermal and nuclear characteristics of the reactor. (W.L.H.)

12555 (GEAP-3558) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Report No. 1, August 1960–September 1960. W. H. Cook (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 10, 1960. 55p. Contract AT(04-3)-189.

The completed Zircaloy-clad fuel design is described, and its fission-gas release and heat-transfer and fluid-flow characteristics are discussed. Results of physical calculations of three "just-critical" Vallecitos BWR core arrays are reported, and the COFFI program for the IBM-704 for steady-state operating characteristics of a reactor is described. Fabrication of stainless-steel fuel assemblies is described, and a detailed description of instrumented assembly designs for core performance and hydrodynamic stability is given. Nonuniform single-rod burn-out data are given, and a new burn-out test section is briefly described. Prototype single- and two-phase pressure-drop measurements were made. (T.R.H.)

12556 (GEAP-3579) HIGH POWER DENSITY DEVELOPMENT PROJECT. Second Quarterly Progress Report, July-September 1960. L. K. Holland (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1, 1960. 59p.

Development of reactor cores having high power density, long fuel life, and low fabrication costs is the program objective. It will be achieved by extensive development and testing carried out in conjunction with the design, construction, and operation of the Big Rock Point Power Reactor. Developments in high-power density fuel, fuel fabrication, stability and heat transfer, physics, and operational planning and test coordination are given. (For preceding period, see Report GEAP-3543.) (W.D.M.)

12557 (GEAP-3643) PRELIMINARY HAZARDS SUMMARY REPORT FOR THE VALLECITOS SUPERHEAT REACTOR. J. L. Murray (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1, 1961. 252p.

Includes Attachment: LICENSE APPLICATION FOR VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR. George White. 8p.

The Vallecitos Superheat Reactor (VSR) is a light-water-moderated, thermal-spectrum reactor, cooled by a combination of moderator boiling and forced convection cooling with saturated steam. The reactor core consists of 32 fuel bundles containing 5300 lb of UO_2 enriched in U^{235} to 3.6%. The fuel elements are arranged in individual process tubes that direct the cooling steam flow and separate the steam from the water moderator. The reactor vessel is designed for 1250 psig and operates at 960 to 1000 psig. With the reactor operating at 12.5 Mw(t), the maximum fuel cladding temperature is 1250°F and the cooling steam is superheated to an average temperature of about 810°F at 905 psig. Nu-

clear operation of the reactor is controlled by 12 control rods, actuated by drives mounted on the bottom of the reactor vessel. The water moderator recirculates inside the reactor vessel and through the core region by natural convection. Inherent safety features of the reactor include the negative core reactivity effects upon heating the UO_2 fuel (Doppler effect), upon increasing the temperature or void content of the moderator in the operating condition, and upon unflooding the fuel process tubes in the hot condition. Safety features designed into the reactor and plant systems include a system of sensors and devices to detect potentially unsafe operating conditions and to initiate automatically the appropriate countermeasures, a set of fast and reliable control rods for scramming the reactor if a potentially unsafe condition occurs, a manually-actuated liquid neutron poison system, and an emergency cooling system to provide continued steam flow through the reactor core in the event the reactor becomes isolated from either its normal source of steam supply or discharge. The release of radioactivity to unrestricted areas is maintained within permissible limits by monitoring the radioactivity of wastes and controlling their release. The reactor and many of its auxiliaries are housed within a high-integrity essentially leak-tight containment vessel. (auth)

12558 (GNEC-138) NUCLEAR SUPERHEAT DEVELOPMENT PROGRAM. Fourth Quarterly Progress Report, April–June 1960. (Combustion Engineering, Inc., Windsor, Conn. and General Nuclear Engineering Corp., Dunedin, Fla.). Nov. 1960. 164p. Contract AT(11-1)-795.

Conceptual design work on the 200-Mw(e) integral boiler-nuclear superheater (NUSU) reactor was continued. Steam conditions of 1200 psig and 1050°F were established as objectives for the NUSU study. The reference NUSU reactor has a central region 6.62 ft in diameter and 9 ft high in which both boiling and superheating occur. Fuel elements in this region are of the double-annular type which transfer heat to water on their outside surface and to steam flowing through their interior passages. The central boiler-superheater region is surrounded by a 0.95-ft-thick boiler region which is also 9 ft high. Fuel-rod cladding in the boiler region was changed from Zircaloy-2 to type 304 stainless steel. The average specific power in the boiler-superheater zone is 13.6 Mw per short ton of uranium; the average power density is 36.2 kw per liter of core volume. In the pure boiler region the average values of specific power and power density are 14 Mev/ton and 36.7 kw/liter, respectively. In the boiler-superheater region the maximum heat fluxes to the water and to the steam are 310,000 and 340,000 Btu/(hr) (sq ft), respectively. In the peripheral boiler region, the maximum heat flux is 374,000 Btu/(hr) (sq ft). Because of the flat power distribution in the superheater region, batch loading of the fuel appears to be preferable to radial shuffling. The maximum temperature of the cladding in the superheater fuel elements is calculated to be ~1225°F. The maximum centerline temperature of UO_2 in the superheater fuel elements is calculated to be only 3700°F, based on an estimate of the hot-channel factors. A study of the shutdown cooling characteristics of the double-annular fuel elements indicates adequate ability to transfer heat to the surrounding water after the heat-generation rate has decayed to 1.42 per cent of the fuel-power level. Criticality was achieved in the first of the NUSU Intermediate Geometry Critical Experiments. The steam purity test loop fabrication and hydrostatic testing were completed. (W.L.H.)

12559 (GNEC-149) NUCLEAR SUPERHEAT DEVELOPMENT PROGRAM. Fifth Quarterly Progress Report, July-September, 1960. (Combustion Engineering, Inc., Windsor, Conn. and General Nuclear Engineering Corp., Dunedin, Fla.). 88p. Contract AT(11-1)-795.

Study of the NUSU superheater-reactor reference design criteria was continued with the investigation of alternate fuel-element concepts and of alternate reactor plant cycles. The principal design effort centered around a multiple-tube fuel-element concept. Two possible fuel-element configurations are under study, differing primarily in the heat-transfer surface areas and in the power split between the boiler and superheater surfaces. In this connection two potential plant cycles were investigated. The large water passages between fuel elements in the superheater region make possible the consideration of natural circulation of the water coolant. An alternate reactor arrangement is presented which uses natural circulation in the superheater region and forced circulation in the boiler region. The study of the effect on shutdown cooling of the natural circulation of steam within the double-annular fuel element was completed. Critical experiments performed thus far provided information on critical size as a function of geometry, of water height, and of simultated steam void content in cores made up of rodtype boiler fuel elements, of 1.85% enrichment, and of rodtype superheater fuel elements of the 3.41% U^{235} enrichment. The relative effects of various cadmium and boron–stainless steel control blades were also compared. The fuel-element design was completed, and the apparatus for preparing the double-annular fuel elements by vibratory compaction was set up and tested. Achievement of 85% of theoretical density on a routine basis appeared to be feasible. The particle-size distribution of the fused powder used in the compaction process was not fully optimized for maximum utilization of the incoming material. Further study is in progress to improve the yield from incoming UO_2 fused powder. Additional work was done on the theory and analysis of critical configurations. The previous calculations were extended to two-region slab reactors using rodtype elements of the boiler and superheater types now on hand for the NUSU critical experiments. In addition, calculations were performed on the configurations to be used in critical experiments with double-annular elements. An enrichment of 2.55 wt.% U^{235} was selected to ensure criticality of the tightest lattice contemplated. The checkout operation of the steam-purity test loop was completed, with steam qualities ranging from 99.5 to over 99.9%. Background total solids entrained in the steam ranged from 2 to 3 ppm. Several minor modifications were made in the loop. The first phase of gravity-separation tests in the high-pressure steam separator loop at Chattanooga was completed. It appeared that the gravitational steam separation is a function of recirculation ratio, of pressure, and of steam release rate. A height of 4 to 5 ft above the steam-water interface appeared to be adequate for all conditions encountered in the integral boiler-superheater reactor designs which were under consideration. This disengagement height increased with the depth of submersion of the inlet nozzle for the steam-water mixture. (auth)

12560 (HRP-185) NINTH QUARTERLY PROGRESS REPORT ON THE OEEC HALDEN REACTOR PROJECT. Covering the Period July 1960–Sept. 30, 1960. (Norway. Institutt for Atomenergi. OEEC Halden Reaktor Prosject). Nov. 4, 1960. 16p.

The reactor was restarted on Aug. 26 and operated up to 10 kw to build up a neutron source. Reactor operation and

safety, research and development, engineering, and radiation protection are summarized. (W.D.M.)

12561 (IDO-28565) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Monthly Progress Report for October 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Nov. 30, 1960. 94p. Contract AT(10-1)-880.

Zero power tests were completed on the Gas Cooled Reactor Experiment Core 1B-2L, and work was initiated to repair the gas leak in the lower reactor flange. Fabrication progressed satisfactorily on the ML-1 reactor package. The 1B-2T-1 test in the BRR was terminated after accumulating 1940 hr of irradiation. Data from corrosion tests on Hastelloy X in air and reference gas for 5000 hr at 1750°F are summarized. Irradiation of the $BeO-UO_2$ capsule was continued. A preliminary draft of a feasibility study for a dual-cycle advanced power system was completed. (For preceding period see IDO-28563.) (W.L.H.)

12562 (IDO-28566) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM MONTHLY PROGRESS REPORT FOR NOVEMBER 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 30, 1960. 97p. Contract AT(10-1)-880.

Underwater repairs to the GCRE were successfully completed, and full-power operation with the 1B-2L core was achieved. Work continued on the preparation and review of operating procedures for the ML-1. Fabrication of the ML-1 package was continued. Gas corrosion tests are reported on Hastelloy-X and yttrium-modified Hastelloy-X. Final revision of a feasibility study for a dual-cycle power system was completed. (W.L.H.)

12563 (KAPL-M-DDD-1) THE DYNAMICS OF A TEMPERATURE AND STEAM VOID POWER COEFFICIENT. D. E. Dougherty (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 27, 1960. 33p. Contract W-31-109-Eng-52.

The dynamic behavior of an axial coolant channel in a power reactor containing steam voids was studied. General expressions for the small signal transfer functions associated with the individual components of the power coefficient were obtained for arbitrary axial power densities, temperature coefficients, and steam-void coefficients (weighting functions). The weighting functions were synthesized by a stepping function with six axial nodes, and the frequency response was obtained for the individual components of a typical power coefficient. The importance of the moving boiling boundary is demonstrated by a Nyquist plot of the open-loop transfer function for the case in which the radial weighting functions were assumed to be uniform. (auth)

12564 (MND-E-2415) ANPP NUCLEATE BOILING PROGRAM. Quarterly Progress Report No. 2 for September through November 1960. C. Eicheldinger (Martin Co. Nuclear Div., Baltimore). Dec. 1960. 29p. Contract DA-44-192-ENG-6.

Design of the test section, supports, and installation was completed. A study of the effect of manufacturing tolerances indicated that the maximum deviation between specified and actual heat flux in the critical notched area was 1.5%. The analog simulation study was completed. Curves showing power and flow variations are included. A motor-generator set is to be installed in the Martin Heat Transfer Loop prior to performance of the test program. This unit is to provide improved transient response and is to enable programming of any credible operational power transient. All instrumentation for the program has been ordered. One major component, the recording oscillograph, has been received. (For preceding period see MND-E-2414.) (auth)

12565 (MND-LFBR-2305) LIQUID FLUIDIZED BED REACTOR STUDY: THIRD QUARTERLY PROGRESS REPORT, MAY 1 TO AUGUST 31, 1960. (Martin Co. Nuclear Div., Baltimore). Sept. 1960. Contract AT(30-1)-2460. 70p.

Work is over 90% complete on the design of the critical experiment, and the construction and planning are progressing according to schedule. The high-pressure abrasion loop insulation was completed, and the loop was manually operated at pellet-testing conditions for 4 hr as an acceptance test of the equipment. The loop control system shakedown was completed. Investigation of the effects of additives, pellet shapes, cladding variables, and fabrication processes is progressing. Screening tests in the ball mills, autoclaves, and low-temperature loops are providing experimental results of the various pellet abrasion samples. (For preceding period, see Report MND-LFBR-2304.) (W.L.H.)

12566 (NAA-SR-4531) AN EVALUATION OF FLUX FLATTENING IN SGR CORES. Roy Arthur Axford (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. Contract AT(11-1)-GEN-8. 67p.

Flux flattening in SGR cores is evaluated from the point-of-view of neutron economy, and its economic feasibility is established. Buckling distributions that yield a specified degree of thermal-neutron flux flattening with a minimum amount of core fuel investment are derived from a variational principle in which the volume integral of the buckling distribution is minimized. These distributions indicate that, in strong degrees of flattening, moderate changes in the core power obtained during the flattening are accompanied by large changes in the core fuel investment, even when those fuel distributions which yield a specified degree of flattening with minimum fuel investment are used. The economic feasibility of flux flattening in SGR cores is established by computing the relative power cost of flattened cores with an unflattened core as the base case. It is shown and concluded that a moderate degree of flux flattening in the radial direction of a cylindrical core constitutes the economic optimum. (auth)

12567 (NAA-SR-5174) DESIGN AND ANALYSIS OF A URANIUM-3.5% MOLYBDENUM ALLOY OMRE CORE. B. L. Hoffman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 30, 1961. Contract AT(11-1)-GEN-8. 150p.

The steady-state nuclear, thermal, and hydraulic analyses of the OMRE core indicate that it can operate safely at 6.8 Mw(t) utilizing existing coolant pumps and process equipment without exceeding a maximum fuel cladding temperature of 750°F. A flow enrichment was selected which provides a sufficient reactivity margin to ensure that the required fuel exposure level can be attained before it is reactivity limited. The OMRE control-rod system was established to have sufficient reactivity worth in the core to allow effective reactor shutdown in its most reactive condition. Additional nuclear analysis determined that the 2.0% reactivity allowance for nonstandard prototype elements in the alloy core is adequate. The nominal power level of 6.8 Mw was designed to allow the fuel to attain a peak burn-up of 11,500 Mwd/MT in ~250 days of operation. Conclusions were made on the basis of transient analyses that no possible accident can result in core damage and fission-product release into the coolant provided the protective system is functioning as designed. A summary is given of pertinent fuel-element and core-design data. (B.O.G.)

12568 (NAA-SR-5619) PHYSICS MEASUREMENTS ON THE SNAP EXPERIMENTAL REACTOR (SER). F. H. Clark, S. G. Wogulis, and M. V. Davis (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 30, 1961. 37p. Contract AT-11-1-GEN-8.

Prior to operation of the SER at temperature and power and with NaK coolant present, a series of measurements were performed in the neighborhood of room temperature and at powers of 1 watt or less. These measurements were designed to establish the characteristics of the system under controlled conditions and to determine safe operating procedures. Measurements were made to determine critical mass in various reflector configurations, control drum and safety element worth, flux mappings in the reactor and importance mappings external to the reactor, reactivity coefficients of various materials, and kinetic parameters. The most important conclusion drawn is that the system as designed has the necessary reactivity and control for its anticipated operation. Full feasibility determinations must necessarily wait upon the outcome of experiments at power and temperature. (auth)

12569 (NAA-SR-5688) PROCEEDINGS OF THE ORGANIC COOLED REACTOR FORUM, OCTOBER 6-7, 1960. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1960. 306p.

The 13 papers of the forum are presented. They deal with coolant, heat transfer, and process development as well as reactors in progress or operating such as OMR, OMRE, EOCR, Piqua Nuclear Power Facility, and OCDR. Separate abstracts have been prepared for each paper. (T.R.H.)

12570 (NAA-SR-5688(p.5-43)) STATUS OF ORGANIC COOLANT TECHNOLOGY. R. H. J. Gercke (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Organic coolant development progress is summarized in a discussion of radiation effects, chemical and physical properties, search for new coolants, and causes of fouling film deposition. High-temperature irradiation of polyphenyl organic coolants at the OMRE and in an extensive in-pile loop study shows that the decomposition rates of these coolants are acceptable. The decomposition products formed are largely of higher molecular weight and are soluble in the coolant. The chemical and physical properties of the coolant undergo acceptably minor changes as the result of decomposition. A continuing search for new coolants has brought forth two materials (alkylphenanthrenes and anthracene oil) that warrant further study. On the other hand the use of inhibitors to reduce polyphenyl decomposition rate does not appear to be economically attractive. Further work is needed to understand the mechanism of fouling, particularly with respect to the role of oxygen-bearing organic compounds in forming the organic portion of the larger particulates. The effect of fast neutrons on the coolant decomposition rate must also be elucidated. (auth)

12571 (NAA-SR-5688(p.45-67)) STATUS OF HEAT TRANSFER DEVELOPMENT FOR ORGANIC REACTORS. W. R. Martini (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Heat-transfer research at Atomics International is oriented toward developing design data for the heat-transfer coefficients, burnout heat fluxes, and fouling factors under both boiling and nonboiling conditions for Santowax OMP irradiated to contain 30% higher boiling compounds. In conducting this research, nine loops are or soon will be available. Four of these are concerned with the testing of the hydraulic and thermal characteristics of fuel elements, and the remainder of the loops, as well as 14 bench scale tests, are concerned with more basic heat-transfer research. Tests have shown that the Dittus-Boelter equation for heating applies within ± 25% to organic reactor coolants. All data for irradiated or unirradiated coolant for plain or finned surfaces fall within this range. Also out-of-pile loop measurements of the rate of increase of fouling resistance show that, for a 900°F surface temperature and 5 to 10 ft/sec fluid velocity, the rate is ~ 0.002(hr)(sq ft)(°F)/Btu-yr, and at 14 ft/sec it is reduced to 0.00001. (Refined hydrocarbons have a fouling factor of ~ 0.001.) Finally, comparative tests of the fouling capability of organic coolants undergoing natural convection heat transfer show that distillation or precoat filtration will remove 95% of this fouling capability from OMRE coolant sampled on Jan. 14, 1960. (auth)

12572 (NAA-SR-5688(p.89-124)) STATUS OF OMR FUEL ELEMENT DEVELOPMENT AT ATOMICS INTERNATIONAL. H. Pearlman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Work on OMR fuel elements has included evaluation of the UO_2–stainless steel cermet fuel elements used in OMRE, and the development of power-reactor elements using metal alloy and UO_2 fuel materials. For the Piqua reactor, the fuel elements consist of as-cast U–3.5 wt.% Mo–0.1 wt.% Al, nickel-bonded to Type 1100 aluminum cladding. Postirradiation examination of prototype elements has indicated generally satisfactory performance up to about 3000 Mwd/MTU, the highest burnup attained in the test series to date. For advanced organic power-reactor designs, where the peak burnup desired is greater than 15,000 Mwd/MTU, other alloys in the U-Mo system, containing up to 10 wt.% Mo, are under investigation. Improved bonding can be obtained with niobium in place of nickel. In order to utilize the known burnup capability of UO_2, an alternate fuel element has also been developed, employing M257 cladding. Out-of-pile compatibility of M257 with UO_2, and with the organic coolant, has been investigated and found adequate. Fabrication of helical finned tubing, joining by flash welding and tube closures made by several methods, has been demonstrated. A test of UO_2–M257 compatibility has been made under irradiation. Preparations are in process for other irradiations, including test elements with deliberately defected cladding, to be made in an organic loop in the NRX reactor. A test element made up of an array of M257 tubes containing UO_2 pellets is available at OMRE for irradiation. (auth)

12573 (NAA-SR-5688(p.125-41)) CURRENT STATUS OF OMR EXPERIMENTAL PHYSICS. H. N. Royden (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Experimental OMR physics studies at Atomics International are surveyed. Age and diffusion length measurements for organic moderators have been made, and an extensive program to study moderating properties of organics is in progress. Criticality calculations and measurements on OMRE have been compared and measurements of intracell fluxes and power, temperature, void and mass coefficients of reactivity have been made. Exponential assembly measurements were made of bucklings and intracell fluxes for slightly enriched U. Two experiments with a 1.9% enriched metal lattice moderated by Santowax R in the OMRCA are described in detail. (T.R.H.)

12574 (NAA-SR-5688(p.143-70)) OMRE OPERATING EXPERIENCE. R. O. Williams, Jr. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The OMRE plant is described and 3 years' operating ex-

perience discussed. The experience has confirmed the overall technical and economic feasibility of the concept by satisfactory performance and low coolant radiolysis rates. Performance data, heat-transfer characteristics, and operating experience for extended periods have been obtained for advanced OMR power-plant designs. (T.R.H.)

12575 (NAA-SR-5688(p.171-87)) CANADA'S RESEARCH AND DEVELOPMENT PROGRAM FOR AN ORGANIC LIQUID COOLED NUCLEAR REACTOR. W. M. Campbell (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Canada's organic-cooled reactor program, based on OCDR, is briefly described. The description includes coolant evaluation, coolant damage, coolant processing, heat transfer, fouling, burnout, pressure-tube development, materials, fuels, general mechanical development, and physics studies. (T.R.H.)

12576 (NAA-SR-5688(p.189-210)) EXPERIMENTAL ORGANIC COOLED REACTOR. Mark R. Dusbabek (Fluor Corp., Ltd., Los Angeles).

The Experimental Organic Cooled Reactor (EOCR), a facility for testing full-sized components and new organic coolants, is described, and its engineering problems are discussed. It is organic moderated and cooled and operates at 40 Mw(t) at 500°F coolant inlet. Plate type fuel elements with stainless-steel-clad stainless steel–UO_2 are used. Experimental facilities include two 6.5- and three 2.5-in. in-pile loops. The information given includes the process system, fuel handling equipment, instrumentation and control, and reactor building and supplementary facilities. (T.R.H.)

12577 (NAA-SR-5688(p.211-24)) THE PIQUA NUCLEAR POWER FACILITY. E. F. Weisner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The Piqua power reactor site and fuel elements are described, and design parameters are given. (T.R.H.)

12578 (NAA-SR-5688(p.225-53)) INTERMEDIATE SIZE PROTOTYPE PLANT. Jay E. Brunings (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The reactor plant, turbine generator plant, and economics of a prototype organic-cooled and moderated (OMCR) nuclear power plant are described and discussed. The fuel is UO_2 pellets in an Al powder metallurgy tube; 144 tubes make up an element. Steam is delivered to the turbine throttle at 850 psig and 630°F to produce 50 Mw of net electric power with a net cycle efficiency of 30.5%. (T.R.H.)

12579 (NAA-SR-5688(p.255-74)) 300 MWE OMCR POWER PLANTS—PRESENT AND FUTURE. R. K. Winkleblack and R. J. Gimera (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Two 300-Mw(e) OMCR power-plant designs are described, one which can be constructed at present, the other a future design. The current-status design is fundamentally the same as the Piqua reactor, the difference being that plate type fuel elements will be used to increase power density. Three basic improvements are incorporated: V–10 wt.% Mo fuel, Nb diffusion barrier, and Al powder metallurgy (APM) material for fuel-element box. The future design would utilize technology demonstrated prior to January 1966. The coolant would be mixed terphenyls at 600°F inlet and 725°F outlet with three primary loops. The fuel is UO_2 clad with APM, in a core 9.3 ft by 10.4 ft long. It is concluded from cost studies that the current-status plant is competitive in high fuel cost areas. The future plant requires some research and development work but will be competitive or more economical than conventional plants. (T.R.H.)

12580 (NAA-SR-5688(p.275-306)) OCDR POWER PLANT STUDY. J. R. Dickinson and R. F. Scarth (Canadian General Electric Co., Ltd., Toronto).

An economic study of organic-cooled heavy-water reactors was made to demonstrate their feasibility in power plants suited to Canadian electrical utility systems. An OCDR plant is described, and steam-cycle and reactor optimization are discussed. It was found that in a 150-Mw plant the economic penalty using a 700°F outlet is 0.2 mill/kw-hr and at 600°F, 0.6 mill/kw-hr compared with a reference design of 800°F. A 100-Mw plant can be built for $420/kw net, 200-Mw plant for $300, and 300-Mw plant for $260. The cost for fueling, operating, and maintenance is 2.9 mills for a 100-Mw plant, 2.1 for 200-Mw, and 1.8 for 300-Mw. A 19-element oxide fuel bundle with graphite filler pieces was compared with a 22-element oxide fuel bundle without filler pieces. The penalty for extra coolant was 0.4 mill/kw-hr in a 100-Mw plant and 0.12 mill/kw-hr in a 300-Mw plant. Organic coolant replacement cost is about 0.2 mill/kw-hr for the 19-element design and 0.3 mill/kw-hr for the 22-element design. (T.R.H.)

12581 (NARF-60-29T) OPTIMIZATION OF REACTOR COOLANT FLOW FOR THE AIRCRAFT SHIELD TEST REACTOR. D. F. Ross (Convair, Fort Worth, Tex.). Oct. 31, 1960. Contract AF33(600)-38946. 88p. (MR-N-261)

The coolant flow for the 3-Mw ASTR was optimized by orificing the fuel-element locations in proportion to the power generated at each location. Measurements taken following the orifice installations indicated a relatively uniform outlet coolant temperature from the fuel-element locations. The successful orificing technique resulted in a 26% increase in the maximum feasible power of the reactor. (auth)

12582 (NMI-7232) POWER REACTOR PROGRAM. PROGRESS REPORT TO E. I. du PONT de NEMOURS & COMPANY FOR THE PERIOD SEPTEMBER 1, 1960 THROUGH SEPTEMBER 30, 1960. S. Isserow, A. M. White, H. F. Sawyer, W. L. Larson, D. S. Kneppel, W. J. Richmond, H. M. Green, P. R. Smoot, and W. B. Tuffin (Nuclear Metals, Inc., Concord, Mass.). Oct. 28, 1960. 28p. Contract No. AT(30-1)-1565.

One tube of the demonstration set of outer tubes was extruded. Two prototype inner tubes were prepared for heat-treatment. Simple bend tests indicated that the diffusion zone formed by heat-treatment of Zircaloy-clad U–1.5 wt.% Mo tubes is less detrimental to ductility than that formed by the diffusion heat-treatment of U–2 wt.% Zr. A prototype unalloyed uranium Vallecitos Boiling Water Reactor tube, designed for a shorter taper, had thin cladding at the front inner surface. The first U–1 wt.% Si extrusion for capsule irradiation specimens deviated from the required dimensions because the cladding broke through the copper jacket and picked up on the die. Fabrication of dingot uranium specimens for capsule irradiation is proceeding. Three stainless-steel–Zircaloy joints were evaluated. (For preceding period see NMI-7231.) (W.L.H.)

12583 (NP-9793) DRESDEN NUCLEAR POWER STATION FIRST QUARTERLY REPORT OF STATION OPERATION. (Commonwealth Edison Co., Chicago). Jan. 25, 1961. 14p.

The total reactor operating time for the period was 1999.9 1.999.9 hr for a total integrated power of 31,707 Mw(t). The reactor was brought to critical 105 times, which reflects the large number of criticals for reactor physics measurements and operator training exercises. A summary is given of the scram history in which five real scrams and six spu-

rious scrams occurred. Leakages in the liquid poison system causing reductions in boron concentration were found and repaired. The effectiveness of operational checks on control-rod drive connections to control rods was demonstrated in the prompt detection of the separation of control rod J-7 from its drive mechanism. The procedures for the disposal of radioactive wastes are described. Radiation surveys throughout the plant over the power operating range demonstrated the adequacy of shielding for both direct and scattered neutron and γ radiations. Personnel exposures were less than the 300-mr weekly exposure limit. The failures and repairs of the in-core neutron monitors are discussed. The cartridge type filter in the waste treatment plant was replaced by a precoat type filter and its associated backwash and charging provisions. Performance data are included for the reactor and turbine generator. (B.O.G.)

12584 (NP-9820) FAST MOLTEN METAL-FUELED POWER REACTOR AN ANALYSIS OF PROBLEM AREAS. H. A. Ohlgren, J. G. Lewis, R. E. Skavdahl, G. A. Coulman, and T. A. Jameson (American Metal Products Co. Engineering Science Div., Ann Arbor, Mich.). Sept. 12, 1958. 101p. (ES-6-T)

Results of preliminary nuclear process engineering research activities in fields of heat transfer and materials to determine whether "fast" molten plutonium-fueled reactors might have application and use as a part of the overall reactor development programs are reviewed. Consideration was given to a specific power reactor whose general purpose is to produce heat and power for industrial applications from plutonium purchased from large breeder and converter reactors. The general criteria of such a fast plutonium "burner" are summarized. Premised upon these general criteria, the numerous areas of research, development, engineering, and testing, which would demonstrate the technical and economic potential of such a system for heat and power generation, were studied. The considerations included the following: preliminary systems concepts and evaluations; preliminary calculations for size, mass, and heat-transfer areas of a molten plutonium-fueled core; and conductive, natural convection, and forced convection heat-transfer calculations. (auth)

12585 (SRO-41) HEAVY WATER POWER REACTOR PROGRAM, Monthly Progress Report, January 1961. (Savannah River Operations Office, AEC.). 17p.

Research and development in physics, engineering, metallurgy as related to heavy-water power reactors are reported. Also reported is progress on the Heavy Water Components Test Reactor. The AEC/AECL Cooperative Power Reactor Program and the Power Demonstation Program. (For preceding period see SRO-40) (J.R.D.)

12586 (TID-6073) NUCLEAR POWER PLANTS FOSSIL SUPERHEAT STUDY. SELECTION OF BOILING WATER REACTOR CYCLE FOR OPTIMIZATION. (Ebasco Services, Inc., New York). May 24, 1960. 18p. Contract AT (30-1)-2524.

With this is bound: NUCLEAR POWER PLANTS FOSSIL SUPERHEATER STUDY. C. A. Cuneo (Foster Wheeler Corp., New York). May 11, 1960. Contracts AT(30-1)-2524 and 2-75-19632.

Results of optimization studies are presented on the application of fossil superheat to boiling-water reactors. It is concluded that in the interest of deriving the most meaningful information regarding this application within the agreed study schedule, the dual-cycle reactor with fossil superheaters for both primary and secondary steam be selected as the reference concept for detailed design and cost estimates. (J.R.D.)

12587 (TID-11368) HEAVY WATER MODERATED POWER REACTOR PLANTS. Engineering Evaluation Studies, Quarterly Progress Report for July–September, 1960. (Sargent and Lundy, Chicago). Oct. 25, 1960. Contract AT(30-1)213. 93p. (SL-1829-1)

Various means for maintaining water purity in primary reactor coolant systems were examined. Most bypass purification systems installed use synthetic organic resins as exchange media. Data were examined on the development of a high-temperature high-pressure axial flow magnetite filter. Results of tests indicate that several corrosion inhibitors are available for decreasing corrosion of carbon steel at 600°F from one-third to one-half. The most effective inhibitors are listed. The testing program designed to quantitatively evaluate the leakage losses of heavy water from mechanical components is being continued. Tests on various types and sizes of seals are reported. A three-phase program was started to correlate the designs of various heavy-water-moderated reactor plants that are in various stages of design and construction in the U. S., Canada, and in Europe. The plants are listed. A comparison was made of the construction account cost differences associated with the 300-Mw(e) boiling D_2O pressure tube direct-cycle plant, and a preliminary design of a conventional 300-Mw(e) steam plant. Pressure tube safety analysis was made for the boiling D_2O prototype. (W.L.H.)

12588 (TID-11707) MONTHLY OPERATING REPORT, JULY 1960. (Duquesne Light Co., Shippingport, Penna.). 39p. Contract AT-11-1-292.

All reference water conditions for the PWR were maintained during the month of July. The modified purification test, DLCS-21302, was continued. This required that the bypass purification demineralizers be out of service. Samples taken of the iodine fission products showed little or no increase in activity during high power operations. An increase in iodine and cesium (136, 137) activities were noted during the load transients of the training and testing period which followed the high power operation. Gross iodine activity was noted in all operating boilers. The presence of I^{131} and I^{133} in the 1B and 1C boilers was confirmed. The presence of I^{133} indicated detectable leakage. The 1A and 1D boilers contained only I^{131}. Radiation and contamination control continued to be the major health physics activity. Acceptable contamination limits were exceeded in normally "clean" areas several times during the month. Personnel contamination was kept at a minimum due to the rapid notification when contamination was suspected to have occurred. A fuel rod exposed to the most severe conditions of neutron and heat flux in the PWR blanket was metallurgically examined for evidence of irradiation or corrosion damage. No significant changes were noted in the dimensions of the rod or in the microstructure of the fuel or cladding. General maintenance included the following: top bearing inspection of the 1D loop main coolant pump, loading the irradiated fuel shipping container, inspection of the 1A boiler feed-water heater, inspection and repair of the 1B boiler feed-water heater, changing of the filter in radioactive waste-disposal system incinerator, and the enlargement of the holes in the radioactive waste-disposal system effluent distributor. In addition, modifications and repairs were made to the plant instrumentation system. (auth)

12589 (TID-11716) MONTHLY OPERATING REPORT [FOR] APRIL 1960. (Duquesne Light Co., Shippingport, Penna.). 44p. Contract AT(11-1)-292.

12590 (TID-11717) MEASUREMENT OF COEFFICIENTS OF REACTIVITY. CORE 1, SEED 1. Test Results T-550132. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, June 6, 1960. 38p. (DLCS-1510201-02-03-04).

Results are presented from tests to determine the temperature and pressure coefficients of reactivity in the power range. The temperature coefficients calculated at power were generally lower than those previously calculated at zero power. The temperature coefficient decreased with increasing EFPH. The pressure coefficients were inconsistent with those obtained in earlier performances. (J.R.D.)

12591 (TID-11724) LEAK TEST OF FEEDWATER HEATERS. Test Results. (Duquense Light Co., Shippingport, Penna.). First issue, Dec. 5, 1960. 7p. (DLCS-3480101; DLCS-3480102; DLCS-3480103; DLCS-3480104; DLCS-3480105)

A test was made to determine if any leaks exist between the tube side and shell side of the feedwater heaters. (W.L.H.)

12592 (TID-11726) FUNCTIONING OF BLANKET DISASSEMBLY EQUIPMENT. CORE I, SEED 1. Test Results T-612381. (Duquesne Light Co., Shippingport, Penna.). Final Draft, Oct. 17, 1960. 8p. (DLCS-1900101; DLCS-1900201; DLCS-1900301)

A test was conducted to check the installation, functioning, and effectiveness of the blanket disassembly equipment under no load conditions, load conditions with the canal area dry, and under load conditions with the canal area filled with water to an elevation of 737.5 ft. It was found that some of the equipment performed poorly during the initial refueling operations of Core I. Various equipment improvements are listed. (J.R.D.)

12593 (TID-11733) INVESTIGATION OF GAS COOLED REACTOR SAFETY PROBLEMS. Progress Report for the Month of January 1961. Lester Goldstein (Nuclear Development Corp. of America, White Plains, N. Y.). Feb. 14, 1961. 5p. Contract AT(30-1)-2303.

The investigation of the safety aspects of the EGCR and HTGR was continued. Studies were initiated which concerned the hazard problems associated with the Florida West Coast Nuclear Power Plant and the Dragon Project. A discussion is given of the information obtained at the HTGR Conference at San Diego and of a literature investigation. The information covers reactivity effects, maximum credible accidents, and chemical reactions in gas-cooled reactors. (For preceding period see TID-11410.) (B.O.G.)

12594 (UCRL-4996) A STUDY OF THE NUCLEAR GASEOUS REACTOR ROCKET. Robert H. Fox (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 31, 1957. Decl. Aug. 25, 1960. Contract W-7405-eng-48. 44p.

A detailed study is presented of some fundamental problems connected with the realization of a nuclear gaseous reactor rocket engine. The virtue of such a propulsion scheme is that the energy of the fission fragments is transferred directly to the propellant. Thus the heat-transfer problem of the conventional heat exchanger type of nuclear rocket is avoided and very high values of the specific impulse (>1000 sec) might be achieved. The discussion centers mainly around containment of the propellant gases during heat addition, maintaining the nuclear chain reaction, and an assessment of the principal factors contributing to cost. It is shown that reasonable values of cost per unit payload are to be achieved only by considering payloads about two orders of magnitude larger than any of current interest. Possible means for improving the situation, such as dissociation-recombination effects, pulsed operation, centrifugal separation of nuclear fuel and propellant, are investigated without reaching favorable results. (auth)

12595 (WAPD-PWR-TE-66) STATION PERFORMANCE AT STEADY LOADS. TEST EVALUATION T-643728, FIRST PERFORMANCE, DLCS-34901, MAY 6 AND 7, 1960. Douglas M. Taylor (Westinghouse Electric Corp. Bettis Atomic Power Div., Pittsburgh). Oct. 28, 1960. 127p. Contract AT-11-1-GEN-14.

Attached to this report is a letter (WAPD-PWR-S(A)-34) containing pertinent data from Mark S. Smith, dated Nov. 9, 1960. 3p.

A study was made to obtain reactor and steam plant data at various load levels from which reactor thermal output, core power distribution, heat exchanger thermal conductance, main unit heat rate, and linearity of nuclear signal with reactor thermal output could be determined. An evaluation for the beginning of PWR-1 Seed-2 life is given. The methods and instrument readings used to determine reactor thermal output are discussed and evaluated. (T.R.H.)

12596 (WCAP-1346) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT, OCTOBER 1959. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). 26p.

A preliminary equipment specification for the design, development, and test of an upward scramming control-rod drive mechanism was prepared. An order was placed for the fabrication of CVTR critical experiment fuel elements. Task 5.00, irradiation experiments, was revised to include additional exposure irradiation tests on tensile, impact, and creep sample specimens of Zircaloy. Corrosion tests were initiated on samples of several possible CVTR control-rod materials and also on various samples of Zircaloy-2 brazed specimens. Construction was started on a thermal cycling facility to test gasketed fittings. An order was placed for the manufacture of seal welding and cutting equipment. This equipment will be used to test the feasibility of repeated welding and cutting of prototype seal weld designs. A study of the AECL work on magnesia-insulated thermal baffles was initiated. Design and layout work were initiated toward applying such a concept to CVTR. Partial analysis of the data obtained from Loop E tests on the fuel assembly showed that the spacer wire pitch has a significant effect on the pressure drop. A study was completed on the design of a gas sweep system that will eliminate the need for seals between the U-tubes and the top neutron shield. (auth)

12597 (CEA-tr-A-802) CONSIDÉRATIONS TECHNIQUES SUR LES INSTALLATIONS DE PROPULSION DES NAVIRES PAR L'ÉNERGIE NUCLÉAIRE, PAR L'INTERMEDIAIRE DE TURBINES À GAZ. (Technical Considerations on Marine Nuclear Energy Propulsion Installations by Means of Gas Turbines). K. Illies. Translated into French from Atomkernenergie, 2: 368-77(1957). 44p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 2195.

12598 (TT-929) SOME PROBLEMS OF DEVELOPMENT OF NUCLEAR POWER STATIONS WITH REACTORS USING WATER, WATER AND STEAM MIXTURE OR SUPERHEATED STEAM AS A HEAT TRANSPORT MEDIUM. T. Ch. Margulova. Translated by O. E. Bruck from Jaderná energie, 6: 222-7(1960). 19p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 22625.

12599 OPTIMUM RATING OF NUCLEAR HEATING POWER PLANTS WITH NITROGEN AS WORKING MEDIUM. K. Bammert (Technische Hochschule, Hanover). Atomkernenergie, 5: 437-47(Dec. 1960). (In German)

For a closed-cycle gas turbine supplying electric power and heat and using nitrogen as a working medium, an economically favorable rating is to be found. Since it is impossible to deal with the effects of all imaginable factors at a time, the only object of consideration is the influence of the expansion ratio of the turbine, on which the investigation is based, and that of the difference between the temperature at the cooler outlet for the working medium and the temperature of the heating water returned. The expansion ratio is determinant for the actual efficiency that can be attained, and thus also for the power production at a given reactor output. Both these factors are determinant for the amount of heat produced. The receipts from power and heat supplies permit calculating the annual total proceeds. It will be seen that the maximum total proceeds cannot be achieved with an expansion ratio resulting in the highest power output. The profitability of the plant depends also on the investment cost. By was of comparison, the cost of the individual units such as compressor, turbine, and heat exchanger can be ascertained. It will be seen that, through the selection of the most favorable temperature difference and expansion ratio at a given investment cost, a maximum of total proceeds can be achieved. By plotting this maximum figure against the investment cost, it is possible to ascertain the cost of establishment which, at a given rate of depreciation, ensures the highest profit. Thus the most favorable rating data of the entire plant can be found. (auth)

12600 THE BOILING WATER REACTOR IN SHIP PROPULSION. H. J. Brüchner (AEG-Kernenergieanlagen, Frankfurt am Main). Atomkernenergie, 5: 448-53(Dec. 1960). (In German)

No report on a specific boiling-water reactor for ship propulsion is given; instead, some peculiarities that this reactor type exhibits for ship propulsion are discussed. These peculiarities are the influence of the ship's motion on the reactivity of the boiling-water reactor, control of the reactor with regard to the maneuvers of the ship, and the aspects of radiation protection due to the fact that, in the case of a boiling-water reactor, the propulsion turbine can be fed directly with the slightly radioactive steam generated in the reactor. (auth)

12601 TRAWSFYNYDD ATOMIC POWER STATION IN NORTH WALES. E. A. Kerez. Brown Boveri Rev., 46: No. 7, 381-4(July 1959).

A brief description is given of the Trawsfynydd power station, including location and builders. A 145-Mw turboset is described. (T.R.H.)

12602 THE BROWN BOVERI-KRUPP HIGH-TEMPERATURE GAS-COOLED REACTOR. R. Schulten and E. Jantsch. Brown Boveri Rev., 47: Nos. 1/2, 88-96 (Jan.-Feb. 1960).

In August 1959 the contract was placed with Brown Boveri and Friedrich Krupp for construction of a prototype high-temperature gas-cooled nuclear reactor developed by them in collaboration. This prototype, with a net electrical output of 15 Mw, will be installed at Jülich, Germany, and operated by Arbeitsgemeinschaft Versuchsreaktor. With the construction of this plant, the Brown Boveri concern has a major share in the realization of the first German project for a nuclear power reactor. (auth)

12603 THE TRAWSFYNYDD NUCLEAR POWER STATION FROM THE TECHNICAL POINT OF VIEW. E. Jantsch. Brown Boveri Rev., 47: Nos. 1/2, 97-106(Jan.-Feb. 1960).

A description of the plant reactors is given. A comparison with the other Calder Hall type reactors shows the progress in the development of graphite-moderated gas-cooled natural-uranium reactors. (auth)

12604 THERMAL PROBLEMS OF ATOMIC POWER STATIONS (IV). DESIGN CRITERIA FOR THE CONTAINMENT OF WATER-COOLED AND WATER-MODERATED REACTORS. E. Jantsch. Brown Boveri Rev., 47: Nos. 1/2, 106-11(Jan.-Feb. 1960).

In the design of nuclear power plants, a most important consideration is the question of protection against the consequences of all conceivable accidents, chiefly the prevention of radioactive fission-product release to the environment. Above all, the design of reactor containments for the highest pressures to be expected after an accident imposes a number of problems, including prediction of the variation of the pressure with time. Using considerations and calculations for actual projects, a comparison between different types of containment is made with respect to their pressure-time behavior and the "inherent" pressuretightness. (auth)

12605 NUCLEAR REACTORS FOR ECONOMIC POWER. A REVIEW OF PRESENT TECHNOLOGY. Zeev Pelled (Israel Atomic Energy Commission, Tel-Aviv). Bull. Research Council Israel. Sect. C, 8: 63-78(1960). (In English)

Advanced designs of power reactor types and possible future developments are discussed in detail. The following reactor types are treated: pressurized light water, boiling light water, graphite-moderated gas-cooled, and heavy-water-moderated. Enrichment with plutonium is considered. A bibliography of 100 references is given. Drawings are presented for the advanced PWR, BWR, Hinkley Point, and heavy-water reactors. (D.L.C.)

12606 ENGINEERING AND ECONOMIC PROGRESS AND PROSPECTS FOR NUCLEAR POWER PLANTS AT THE PRESENT. José Maria Otero Navasués. Energia nuclear (Madrid) 4: No. 14, 15–31(April–June 1960). (In Spanish)

An analysis of the economic and engineering possibilities of reactors in operation or under construction and the projection of the data to the years 1966 to 68, made by the Reactor Development Division of the USAEC, is considered with respect to the power needs and nuclear technology of Spain. (J.S.R.)

12607 ACTUAL STATE OF NUCLEAR NAVAL PROPULSION. Francisco Pascual Martínez. Energia nuclear (Madrid) 4: No. 14, 32–48(April–June 1960). (In Spanish)

The present utilization of nuclear power for naval and marine propulsion is reviewed. The military program of the United States for nuclear-powered submarines and surface vessels and the program of other countries are first discussed. Merchant vessels are described with a consideration of the Savannah and the Lenin. In conclusion, future plans for nuclear-powered merchant ships are indicated. (J.S.R.)

12608 FUEL ELEMENTS FOR HIGH TEMPERATURES: PRESENT STATUS AND PROSPECTS FOR THE FUTURE. A. Boettcher (G.F.K.F., Düsseldorf). Energia nucleare (Milan), 8: 45-50(Jan. 1961). (In English)

The technical and economic problems concerned with the choice of fuel and can materials for high-temperature reactor fuel elements and the solutions adopted or being studied are reviewed. The various reactor types taken into

consideration are the liquid-cooled reactors (with particular regard to the sodium-cooled ones) and the gas-cooled reactors (the Advanced Gas Reactor, the Dragon, and the reactor concept having heterogeneous or homogeneous ball-shaped fuel elements). (auth)

12609 POWER REACTORS AND REACTOR SAFETY. T. J. Thompson (Massachusetts Inst. of Tech., Cambridge). Energia nucleare (Milan), 8: 62-70(Jan. 1961). (In English)

The problem of setting up a relationship between public safety and radioactivity release from reactors in normal operation as well as in the case of accident is discussed. Safety criteria that would best guide reactor design (container, pressure vessel, fuel elements, instrumentation, and control), construction (inspection and testing), and operation (selection, training, and organization of the personnel) are delineated. The considerations are confined to water-moderated reactors. (auth)

12610 GAS COOLED REACTORS AND THEIR FUTURE EVOLUTION. Mario Carchidio. Ing. nucleare, 3: 118-26 (May-June 1960). (In Italian)

Various factors which would permit a considerable reduction in cost of the energy produced in gas-cooled reactors are examined. Particular attention is given to the analysis of the coolants which can be used. The achievement of high temperatures and pressures in the primary circuit calls for enriched or ceramic fuels and for containers having considerable wall thickness. In view of the above factor, a study is made on the possibilities offered by present-day technology in these fields. Mention is also made of the improvements obtained in the utilization of the thermic power extracted from the reactor as a function of coolant exit temperature. This study shows that, even without having recourse to gas turbines, these installations can achieve efficiencies of up to 40%. After a brief examination of some existing prototypes for advanced research on gas-cooled reactors, a report introduced to the Second German Conference on Nuclear Naval Propulsion, held in 1959, is reviewed. This report shows that the gas-cooled reactor will be the most economic one to operate for naval propulsion, once all developments and improvements presently under study are introduced. (auth)

12611 THE INFLUENCE OF THE SURFACE TEMPERATURE INCREASE OF A FUEL ELEMENT ON THE THERMAL EFFICIENCY OF A NUCLEAR POWER STATION. Vladimír Zajíc (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderná energie, 7: 10-12(1961). (In Czech.)

Further factors having an influence on the surface-temperature increase of a fuel element and on the thermal efficiency of a nuclear power station are given. (auth)

12612 DYNAMIC ANALYSIS OF A BRITISH TYPE GAS COOLED REACTOR DURING LARGE POWER CHANGES. THE DISCUSSION OF RESULTS AND THE CONCLUSIONS. Junichi Miida (Japan Atomic Energy Research Inst., Tokyo). Nobuhide Suda, Tetsuo Takeuchi, and Toshio Irie. J. At. Energy Soc. Japan, 3: 33-9(1961). (In Japanese)

Results and conclusions obtained from a dynamic analysis of a British type gas-cooled reactor during large power changes are described. In the case of continuous control, a gain of 0.2 mN/sec°C, and a derivative time of 50 sec were considered optimum. In the case of discontinuous control the values were a gain of 1 mN/sec and a derivative time of 50 sec. It was found that the power could be stably changed with a flow change rate of 10%/min. Continuous control was found to be better than discontinuous as far as the behavior at steady state is concerned, but no difference was found for the case of transient behavior. There was no difference in the effects on fuel-element temperature if the optimized controller constants were adopted. (auth)

12613 THE 15 MW BWR AT KAHL. DESCRIPTION OF THE PLANT. R. Kühnel (Atomic Energy Div., AEG). Nuclear Eng., 6: 56-65(Feb. 1961).

A detailed description is given of the 15-Mw BWR plant at Kahl/Main. The description includes the steam generating plant, fuel elements and core, control rod drives, emergency poisoning, pressure vessel, secondary coolant circuit, load following, emergency cooling, shield cooling, water treatment, gas removal, ventilation, liquid effluents, fuel changing, turbine plant and instrumentation, and construction report. (T.R.H.)

12614 PLUTONIUM FOR PROPULSION REACTORS. Joan Hill (Rolls-Royce, Ltd., Derby, Eng.). Nuclear Eng., 6: 66-8(Feb. 1961).

The use of plutonium isotope mixtures simplifies the reactivity control problem in low-enrichment propulsion reactors. The reactivity effects of such a fuel are discussed. It is concluded that although the enrichment (Pu^{239} + Pu^{240}/atom of uranium) required for a given reactor life depends on reactor structure and the neutron spectrum, the general shape of the curves is not very sensitive to the parameters used in the calculations. Plutonium containing 80% Pu^{239} and 20% Pu^{240} gives long core life, the Pu^{240} making an excellent burnable poison. Plutonium from civil power stations contains isotopes in about the right proportions. (T.R.H.)

12615 POWER REACTOR TECHNOLOGY. Technical Progress Review, Vol. 4, No. 1. Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). Dec. 1960. 82p. $0.55(GPO) (Domestic), $0.70(GPO) (Foreign).

Information is reported on evaluations of small power reactors. Reactor physics investigations include flux hardening effects, resonance adsorption and Doppler temperature coefficients, thermal-neutron diffusion parameters, power distributions in water-moderated lattices, and critical and exponential experiments. Heat-transfer and fluid-flow studies include liquid cooling, gas cooling, and hot-channel factors. Investigations on various reactor hazards are reported. Studies are reported on the development of carbide fuels and on fission-product release from fuels. Studies are also reported on the power demonstration reactors, organic-moderated reactors, gas-cooled reactors, and nuclear superheaters. (W.L.H.)

12616 HEAVY-WATER-MODERATED NUCLEAR POWER PLANTS. M. S. Silberstein (Nuclear Development Corp. of America, White Plains, N. Y.), J. De Felice, W. A. Loeb, and W. A. Chittenden. Paper 59-A-185. Presented at the ASME Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959. New York, The American Society of Mechanical Engineers, 1959. 11p. $0.80.

Studies have been carried out on the relative near-term economic promise of natural-uranium-fueled heavy-water-moderated reactor power plants. A 200 Mw(e) direct-cycle plant using boiling D_2O coolant in a pressure-tube reactor has been recommended, and a 70 Mw(e) natural-uranium prototype is described which can be built based on current technology. The factors leading to the selection of this plant are reviewed briefly, and some of the unusual engineering considerations concerning mechanical, thermal, economic, and plant equipment aspects of the design are discussed. (auth)

12617 OPERATING EXPERIENCE AND ADVANCED DESIGNS OF SODIUM-GRAPHITE REACTORS. R. W. Dickinson and L. E. Glasgow (Atomics International, Canoga Park, Calif.). Paper 59-A-192. Presented at the

ASME Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959. New York, The American Society of Mechanical Engineers, 1959. 9p. $0.80.

The principal significant information gained from two years of operation and tests of the sodium-reactor experiment is given. In operation at a steam temperature of 1000°F, the strong negative power coefficient of reactivity, -0.22×10^{-4} (ΔK/K)/Mw(t); reactor stability; and 20% per min power-ramp rates were noted. Equipment performance including 75,000 hr of pump operation is reported. Design considerations leading to a novel reactor arrangement which improved the neutron economy, reduced thermal stress, and improved maintenance, are outlined. Advanced designs extending the performance and reducing the costs of sodium-cooled reactors are described. Electrical power costs in the range of 5.0 to 5.4 mils/kw-hr are indicated. (auth)

12618 BOILING-WATER-REACTOR STUDY. William A. Hartman (General Electric Co., San Jose, Calif.). and Leonard F. C. Reichle. Paper 59-A-298. Presented at the ASME Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959. New York, The American Society of Mechanical Engineers, 1959. 13p. $0.80.

The conceptual design is presented for a large boiling-water-reactor power plant to start construction in July 1960. The plant described represents modest advancements in boiling-water-reactor design with research and development compatible with the required construction schedule. (auth)

12619 AN ADVANCED PRESSURIZED-WATER-REACTOR ELECTRIC GENERATING STATION. J. B. Anderson (Combustion Engineering, Inc., Windsor, Conn.) and C. T. Chave. Paper 59-A-302. Presented at the ASME Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959. New York, The American Society of Mechanical Engineers, 1959. 23p. $0.80.

A design evaluation is presented of a pressurized-water nuclear power plant conducted by Stone and Webster Engineering Corporation and Combustion Engineering, Inc. The main lines of development leading to economically competitive pressurized-water nuclear power plants include higher thermal efficiency achieved by raising the average coolant temperature near the saturation temperature, improved core design providing uniform power distribution, uniform fuel burnup and extended reactivity lifetime, economical and safe means to control excess reactivity required for extending core lifetime, and over-all system simplification. Improved core-design concepts, multiregion loading, spiked cores, control of long-life cores, fuel cost, thermal plant efficiency, and self-pressurized reactors are discussed. (auth)

12620 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CONTROL ARRANGEMENTS. Roy Jackson Smith (to General Electric Co., Ltd.). British Patent 858,339. Jan. 11, 1961.

A reactor control system is described which is suitable for control of a reactor whose load is variable. The system is comprised of a power setting device and an associated function generator, the power setting device controlling the coolant flow in dependence on the desired power output and the function generator controlling the neutron flux control means in dependence on a suitable derivative of the coolant flow signal. In this way, the outlet coolant temperature can be kept constant. The function generator can be operated with linear or nonlinear power level dependence on coolant flow. Means is provided for closed-loop feedback control. (D.L.C.)

12621 IMPROVEMENTS IN OR RELATING TO GRAPHITE MODERATED NUCLEAR REACTORS WITH PARTICULAR REFERENCE TO CORE STRUCTURES THEREFOR. Andrew Thomson Bowden (to C. A. Parsons and Co., Ltd.). British Patent 861,791. Feb. 22, 1961.

Under irradiation, graphite stores up energy and must be kept above a certain temperature in order to prevent sudden release of this energy and consequent risk of fire. A method is given for keeping above this temperature the inlets of the cooling channels in gas-cooled graphite-moderated reactors, which are subject to the cooling action of relatively cool gas. In this method, graphite sleeves are provided in the channels near the inlets and spaced from the core to form spaces that are filled with stagnant gas. To prevent energy release in the sleeves themselves, the natural uranium fuel elements may be replaced for short periods by elements of an enriched fuel in stainless-steel containers. Such elements can operate at higher temperatures with consequent raising of the coolant temperature at the inlets. (D.L.C.)

12622 FUEL ASSEMBLY FOR VERTICAL-CHANNEL NUCLEAR REACTOR. (to Commissariat à l'Énergie Atomique). British Patent 861,800. Feb. 22, 1961.

A fuel assembly comprising a tubular casing is designed for use in reactors that are moderated and cooled by a liquid, particularly heavy water. The sheathed fuel cartridges are supported inside the casing by internally projecting lugs and teat-recess coupling of adjacent cartridges. The liquid is drawn into the assembly and out, ~10% being drawn off for detection of sheathing ruptures. The assembly is supported in the reactor at both the top and bottom, and a cased spring is provided to hold the casing against the tank base plate and to absorb any casing expansion. A degassing device is also provided. (D.L.C.)

Research Reactors

12623 (BMI-ACRS-659) HAZARDS SUMMARY REPORT FOR THE BATTELLE PLASTIC REACTOR FACILITY. David A. Dingee and Joel W. Chastain, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 20, 1961. 64p.

Experiments using a plastic-moderated assembly as a radiation source are described, and the hazards attendant to these experiments are evaluated. The critical assembly, designated Battelle's Plastic Reactor Facility, is constructed in the form of a cube. A portion of the plastic and fuel will be removed from the center of this reactor to provide a radiation environment for exposing fission-chamber devices. This central void region will approximate a flux trap in which a high neutron-to-gamma ratio is expected. The fuel-element assemblies are composed of strips of aluminum and Teflon-coated uranium sandwiched with plastic and encased in aluminum boxes. One portion of the core is on a movable table, while the other part is on a fixed table. The core is assembled remotely by driving the movable table against the fixed table. Primary control and safety of the assembly are achieved by inserting or withdrawing regulating and safety elements and by increasing or decreasing the distance between the two core halves. For safety, the maximum normal rate of reactivity addition has been limited to 0.04% Δ k/k per sec for control-element withdrawal and table closure. The system is interlocked so that only one control element can be withdrawn at a time and so that the movable table and elements cannot be moved simultaneously. In addition, criticality cannot be reached by only moving the tables together. No experiments with the Plastic Reactor Facility are planned since it will

serve only as a source of radiation operating at a constant power level. Consequently, the hazards of a nuclear excursion are minimized. However, the safety aspects of the operations and possible power excursions have been analyzed. The analysis indicates that these operations present no significant hazard to the public persons or operating staff. (auth)

12624 (CEA-1599) PILE MELUSINE. MESURES DE RAYONNEMENT EFFECTUEES AU DEMARRAGE ET PENDANT LES PREMIERES MONTEES EN PUISSANCE. (The Reactor Melusine. Radiation Measurements Carried out at the Start of Operation and During the First Ascents to Power). V. Coutrot, J. Delpuech, and L. Fitoussi (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 53p.

The results are given of radiation measurements carried out on the first CEA swimming-pool pile, Mélusine. The purpose of these measurements, which were carried out during the starting-up period and the first ascents to 1-Mw power, is to check the radiation intensity levels near the pile and from this to verify the safety calculation methods used. In addition, certain special measurements such as those performed in and above the water of the swimming-pool, and in the channels and outside them should make it possible eventually to define the conditions under which the pile may be used for special jobs with less protection. In the first part of the report are given the results of radiation measurements carried out during runs at low-power plateaus not exceeding 500 watts: in particular measurements at variable water levels in the water of the swimming-pool and on the axis of the open channels. The results given in the second part deal with radiation measurements performed in various parts of the premises, studies on the activation of the plugs in the experimental channels and of the materials in the forward compartment, and also of the radioactivity of the swimming-pool water and the air used to cool the channels. (auth)

12625 (HW-60931) PRTR SINGLE TUBE PROTOTYPE MOCKUP (STPM) OPERATIONAL CHARACTERISTICS. P. A. Scott (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 2, 1959. 28p.

The Single Tube Prototype Mockup (STPM) was constructed as a water source at Plutonium Recycle Test Reactor (PRTR) conditions of flow, pressure, and temperature, and to evaluate possible mechanical difficulties in a prototype vertical process tube charged with a suspended fuel element and hanger assembly. The Phase I 2½-in. carbon steel loop is designed for operation to maximum conditions of 2400 psig, 650°F, and 200-gpm flow. Phase II, the 14-in. carbon steel loop, was constructed for temporary use at PRTR maximum operating conditions of 1250 psi and 550°F, and primarily for testing primary pumps, 14-in. gate valves, and 8-in. check valves. Discussions are included of: heating and cooling; pressurization and level control; test sections; pumps; operating characteristics of valves, heat exchangers, strainers, safety heads, and immersion heaters; and safety precautions for the STPM. (B.O.G.)

12626 (HW-61346) PRTR TOTAL ENERGY DISTRIBUTION CALCULATIONS. R. E. Peterson and J. Muraoka (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 31, 1959. 5p. Contract AT(45-1)-1350.

A refinement of earlier values is presented which includes a calculation of the energy fraction which is released in the PRTR shroud and process tubes that flows to the primary coolant and moderator. The heat transferred from the primary coolant to the top and bottom shield coolant is also taken into consideration. Nuclear data used in the original calculations appear satisfactory and are, therefore, utilized in the present analysis. Results of the heat-transfer and physics analysis indicate that the primary coolant removes 94.8% or 66.4 Mw of the 70 Mw nominal total power. The reflector energy is 0.92% or 0.606 Mw. The total heat load on the top and bottom shield coolant is 0.78% or 0.545 Mw. In addition, 0.36% or 0.251 Mw is removed in the radial cast iron shield; therefore, the total energy removed by all the shields is 1.14% or 0.796 Mw. Then by the difference of the heat removed by the primary coolant, shields, reflector, and total heat, the moderator heat load is 3.14% or 2.2 Mw. Previously, the moderator heat load was estimated at 2.019 Mw. Calculations based on the hottest channel indicate that moderator boiling on the surface of the shroud tube will not occur when the process tube is centered. However, if the process tube is off-center by 0.219 in., mild surface boiling may occur. Temperature calculations in the exposed shroud tube above the moderator level of the hottest channel indicate that the maximum is 560°F, and temperature calculations at the upper surface of the moderator indicate that mild boiling will occur on the shroud tube surface. (auth)

12627 (NARF-60-30T) EXPERIMENTAL MAPPING OF THE IRRADIATION VOLUMES OF THE CONVAIR RADIATION EFFECTS TESTING FACILITY. B. F. Freeman and F. F. Fleming (Convair, Fort Worth, Tex.). Nov. 30, 1960. Contract AF33(600)-38946, System No. 9-1-(125A). TASK III, ITEM 4. (MR-N-262)

An experiment involving neutron and γ measurements in the irradiation volumes of the Radiation Effects Testing Facility for a dry-pool configuration was carried out. The purpose of the experiment was to map the radiation field in the region normally used for radiation-effects investigations. Each of the three inrradiation volumes constituting this region was mapped with detectors spotted in a minimum of 17 locations in each of three rack positions. Neutron measurements were made with sulfur and cobalt detectors; γ measurements were made with chemical dosimeters. The detectors were irradiated for 3 hr at a reactor power lever of 500 kw. The maximum fast neutron flux (E > 2.9 Mev) received was 7.1×10^4 neutrons/cm^2/sec-watt; the maximum thermal neutron flux, 2.3×10^3 neutrons/cm^2/sec-watt; and the maximum γ dose rate, 2.8×10^{-1} ergs/g(C)/sec-watt. (auth)

12628 STUDIES ON THE JRR-1 WITH SPECIAL REFERENCE TO THE FUEL SOLUTION. I. GENERAL DESCRIPTION. J. At. Energy Soc. Japan, 3: 40-54(1961). (In Japanese)

A series of tests designed to study problems which arose in three-years' operation of the JRR-1 were planned and carried out. Special emphasis was placed on a study of fuel problems. The state of corrosion in the core tank wall, behavior of the gas recombination water, the condition of the fuel solution, and an abnormal decrease in reactivity were among the problems investigated. It is believed that repetition of tests will give much more detailed information. (auth)

12629 STUDIES ON THE JRR-1 WITH SPECIAL REFERENCE TO THE FUEL SOLUTION. II. CHEMICAL ANALYSIS. Kenji Motojima, Hiroshi Hashitani, Takuji Komori, Shoji Bando, Tadashi Yamamoto, Shuzo Tamura, and Ryoshi Ishiwatari (Japan Atomic Energy Research Inst., Tokyo). J. At. Energy Soc. Japan, 3: 55-68(1961). (In Japanese)

As a part of the extensive study of the JRR-1, several chemical analyses were made of the fuel solution, the

recombiner water, and the solution that remained in the drain tank. The volume change of the fuel solution was confirmed by the measurements of the density and the uranium concentration. The isotope dilution method and oxine extraction-photometry were used for the determination of uranium. The corrosion products and metals added to the fuel solution, i.e., iron, nickel, chromium, and copper were determined. The extraction-photometric methods that were developed previously were modified and applied to the determination of iron and copper with oxine, nickel with dimethylglyoxime, and chromium with 2-methyloxine. The extraction was carried out in a lead-shielded cave, whereas absorbance measurements were made in an ordinary manner because of negligible radioactivity of the extract. The amounts of uranium and sulfate, which were transferred from the core tank, and corrosion products in the recombiner water were determined. The amounts of uranium and corrosion products in the drain tank were estimated from the determination of these elements in the washings of the tank. Because of the low radioactivity of these samples, the determinations of uranium, iron, nickel, and chromium were made by extraction-photometry without special shielding. The sulfate was determined photometrically by means of barium chromate. (auth)

12630 ELECTRICAL EQUIPMENT OF THE CZECHOSLOVAK NUCLEAR REACTOR AFTER THREE YEARS OF OPERATION. František Voženílek (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderná energie, 7: 6-9(1961). (In Czech.)

Operational experience with the electrical equipment of the Czechoslovak research reactor in the Institute of Nuclear Research of the Czechoslovak Academy of Science in Řež gained since the start-up of the operation of the reactor is described. (auth)

12631 PREDICTION OF THERMAL-NEUTRON FLUXES IN THE BULK SHIELDING FACILITY FROM LID TANK SHIELDING FACILITY DATA. A. D. MacKellar (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 9: 284-6 (Feb. 1961).

A calculation predicting the neutron flux in the Bulk Shielding Facility (BSF) on the basis of Lid Tank Shielding Facility (LTSF) data transformed first to a point-to-point kernel and then to the geometry of the BSF reactor was performed in order to check the powers quoted for the two reactors. A discrepancy between the predicted and measured fluxes indicated either that one of the quoted powers was in error or that the geometrical transformations were not properly derived. The agreement between measured and calculated fluxes appeared to be good for larger distances, but there was a discrepancy of 12 to 22% for distances closer than 60 cm from the reactor. (M.C.G.)

WASTE DISPOSAL AND PROCESSING

12632 (BAW-28) A BIBLIOGRAPHY ON WASTE DISPOSAL. Ann T. Curran (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Aug. 1957. 40p.

About 450 annotated references are presented on waste disposal as related to the atomic energy industry. The sources included Nuclear Science Abstracts, 1953 to 1957, Abstracts of Classified Reports, 1953 to 1955, Confidential Reports for Civilian Applications, 1955 to 1957, Secret Reports for Civilian Applications, 1956 to 1957, and Industrial Arts Index, 1953 to 1957. (T.R.H.)

12633 (BLG-50) PRODUKTIE, BEHANDELING EN STORTING VAN RADIOAKTIEVE AFVALWATERS. (Production, Processing, and Storage of Radioactive Wastes). (Thesis). P. Dejonghe (Brussels. Centre d'Étude de l'Énergie Nucléaire). June 8, 1960. 209p.

An estimate of the future production of radioactive waste materials and the discharge possibilities in Belgium are employed to calculate the required decontamination factor. A system for water purification, including the precipitation of Cs^{137} by addition of $K_4Fe(CN)_6$ and $CuSO_4$ and the precipitation of most of the bi- and trivalent cationic radioisotopes by addition of Na_3PO_4 and $Ca(OH)_2$, led to the removal of more than 98% of the fission products and the α emitters. The subsequent filtration of the effluent through a lignite bed, deposited inside a centrifuge, led to the removal of approximately 99.9% of the Sr^{90}, β-γ emitters, and α emitters. It was proved that the rate of fixation is highly improved in the centrifugal field. In order to simplify the storage of the radioactive concentrates, it was envisaged to include them in a tar melt. (auth)

12634 (DLCS-1690202) RADIOACTIVE WASTE DISPOSAL SYSTEM PERIODIC RADIATION MONITORING SURVEY. CORE I, SEED 1. Test Results T-612075. Section 2. (Duquesne Light Co., Shippingport, Penna.). Oct. 10, 1960. 17p.

The radiation level of all permanently installed monitored points in the Radioactive Waste Disposal Plant was determined periodically, and the effectiveness of shielding facilities in working areas at times during which the radiation level was above limits set up by Health Physics was checked. The radiation level in all areas surveyed was less than 5 mr/hr, which is the Health Physics' limitation for the Radioactive Waste Disposal Area. Any area with a level above 5 mr/hr is a controlled access area posted with warning signs. (auth)

12635 (HW-66571) RESEARCH AND DEVELOPMENT ACTIVITIES; FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, April–June 1960. D. W. Pearce, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 15, 1960. Contract At(45-1)-1350. 30p.

Progress is reported in research and development work in the field of fixation of residues from radioactive wastes. The areas of investigation include studies of various waste-treatment processes, such as calcination, fixation in silicates, and utilization of certain minerals having selective retentivity for certain isotopes or groups of isotopes, as well as waste-disposal studies and economic aspects of both treatment and disposal. Waste calcination studies were continued in the fluid-bed calciner using simulated high acid Purex waste as feed. A batch calcination facility capable of handling pots 54-in. high and 14-in. in diameter was built. Studies were continued on methods of improving the thermal conductivity of calcined powder. Data are included on the effect of feed rate, steam pressure, and sugar concentration on powder holdup on the column walls and on the extent of calcination of the powder formed from Purex waste. Neutralized Zirflex waste was successfully calcined. Corrosion tests were continued. Laboratory experiments were conducted to study the effect of γ irradiation on the ability of clinoptilotite to absorb cesium. Studies were also made on the influence of solution pH on anion replacement reactions in minerals. Laboratory studies to investigate the possibility of direct decontamination of some types of high-level wastes gave promising results. The effectiveness of clinoptilolite colums was tested with aged Redox high-salt waste, aluminum coated wastes, and Purex high-salt wastes.

Data are tabulated from tests on cesium removal by clinoptilolite. The arrangement of the micro pilot plant used in the studies is illustrated photographically. Several metals were examined to determine their ability to decontaminate ruthenium. (For preceding period, see HW-65209.) (C.H.)

12636 (HW-67282) PILOT SCALE ALUMINUM BED DECONTAMINATION OF REACTOR EFFLUENT. I. DESIGN, OPERATION AND PRELIMINARY RESULTS. H. G. Rieck (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 12, 1960. 23p. Contract AT(45-1)-1350.

An evaluation was made of the reactor effluent decontamination characteristics of a 20-ft column of aluminum shavings at flow rates of 3.8 and 6 ft/min. The decontamination efficiencies were 65 and 45% for P^{32}; 70 and 52% for As^{76}; 80 and 80% for Zn^{65}; and 21 and 16% for Np^{239}, respectively. The maximum radiation intensities were 450 and 1600 mr/hr; and the pressure drops across the bed were 0.12 and 0.32 in./ft of bed length, respectively. The mechanical bed stability was deemed excellent for both flow rates. An evaluation of the bed life was not made. (B.O.G.)

12637 (HW-67514) PREDICTED CHARACTERISTICS OF PRTR LIQUID EFFLUENTS. W. A. Haney (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 22, 1960. Contract AT(45-1)-1350. 14p.

The majority of the radioactive material (excluding tritium) discharged to the Columbia River from the PRTR during periods of normal operation should consist of neutron-activation products from irradiation of impurities in the single-pass water coolant. However, a heavy-water leak of maximum tolerable magnitude, 10 gal of D_2O/day, would result in a tritium concentration comprising about 90% of the estimated gross-beta emitter concentration in the effluent. It is doubtful that radioisotopes discharged to the river from the PRTR will be detectable in downstream water supplies. Certainly the concentration of radioisotopes at downstream locations attributable to the PRTR will be a very small fraction of the limits specified in Hanford Radiation Protection Standards. A comprehensive waste-sampling program is recommended, particularly during and immediately following reactor startup, to obtain radioisotope analytical data necessary for a more accurate evaluation of this type. (auth)

12638 (NAA-SR-Memo-886) RADIOACTIVE WASTE DISPOSAL AT NORTH AMERICAN AVIATION, INC. J. C. Lang (North American Aviation, Inc., [Downey, Calif.]). Feb. 8, 1954. 11p.

A detailed description is given of the radioactive waste disposal procedure currently in use at the Atomic Energy Research Department of North American Aviation, Inc., complete with an economic evaluation. (auth)

12639 (NAA-SR-Memo-1774(Rev.)) PROPOSAL FOR THE DESIGN OF A RADIOACTIVE WASTE STORAGE FACILITY AT THE SRE SITE. G. Borg, A. A. Jarrett, and J. C. Lang (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 7, 1957. 17p.

Waste handling by semi-permanent storage is employed extensively through the industry at reactor and fuel processing sites. The costs are competitive with other methods of waste disposal and processing. The major design problem lies in formulating a facility with adequate flexibility to handle the many configurations of packaged wastes and components. Over the period considered, from 4000 to 7000 packaged units of high-level liquid and solid wastes may be stored. From 600 to 1000 packaged units of low-level wastes will be received at the facility each year. Components from the various projects will add to these totals. The design and final proposal shall also be considered in relocating some existing or planned waste handling facilities at individual projects to the centralized facility. Transportation of wastes to the facility is another important consideration. One of the major objectives of the AEC waste disposal development program in the Division of Reactor Development is to develop better and cheaper ways for safely handling and disposing of all radioactive wastes from reactors, chemical processing plants, and other radiological operations. The construction of a radioactive waste handling facility is basic to the Commissions waste disposal program and satisfies the requirements of affording adequate, safe, and economic handling of radioactive waste materials. The proposed facility is adequate and safe in that all waste materials are stored, thereby nullifying risks of environmental contamination and subsequent radiological hazards to surrounding populations. The proposed facility is economical since cost for waste storage is less than or competitive with other means of waste handling and disposal, and operational shutdowns of Commission-sponsored projects due to radioactive waste problems are minimized. (auth)

12640 (NYO-4443) CONVERSION OF ALUMINUM-BEARING FISSION PRODUCT WASTES TO VITREOUS FUSIONS. M. I. Goldman, R. T. Burns, R. S. Daniels, J. D. Sehgal, J. Servizi, T. H. Y. Tebbutt, and R. Eliassen (Massachusetts Inst. of Tech., Cambridge, Sedgwick Labs. of Sanitary Science). [June 1960]. 71p. Contract AT(30-1)-621.

Research is reported on a process for the immobilization of fission products contained in acid aluminum nitrate wastes by conversion of the waste solution to a relatively insoluble, high-melting glass that can be stored more safely than the original liquid. It is possible to incorporate high-activity aluminum-bearing fission product wastes in fused ceramic formed at temperatures over 1000°C, with either the liquid waste or a calcined product as the initial source of aluminum. Glass corrosion rates as low as 4×10^{-6} cm/week in boiling distilled water were obtained. Irradiation with γ rays at doses up to 109 r have no significant deleterious effect on the solubility of the fused glass product. Cesuim is evolved during the firing process although other work indicates that it is retained in the clay crucible in which the fusion is accomplished. (W.L.H.)

12641 (ORNL-3035) STATUS REPORT ON EVALUATION OF SOLID WASTE DISPOSAL AT ORNL. [PART] I. K. E. Cowser, T. F. Lomenick, and W. M. McMaster (Oak Ridge National Lab., Tenn.). Feb. 24, 1961. Contract W-7405-eng-26. 42p.

The criteria employed in selecting a site for disposal of solid wastes, the methods used in evaluating a site, and preliminary analysis of a new burial trench design are discussed. Auger wells were drilled to determine the character of the residual cover, the depth of the water table, and the chemical and radionuclide composition of the ground water. A descriptive geologic map, and depth-to-water and water-table contour maps were prepared. Deeper wells were drilled to determine the occurrence and circulation of ground water at greater depth in the burial area. Pressure tests of the deep wells showed that the most permeable zones or fractures occur within the first 100 ft. Hydrographs for the deep wells showed a maximum water-level fluctuation of 14 ft and a minimum fluctuation of 1.5 ft over a period of approximately 8 months. An estimate of the requirements of land usage from records of solid waste burial dating back to 1957 revealed that an additional 2.0×10^6 ft^3 of solid waste will be buried at ORNL through 1964.

Using depth-to-water maps and restricting the depth of burial to 1 ft above the highest water level, it was determined that approximately 21×10^6 ft^3 of volume is available for disposal of solid waste. To improve operations and monitoring, a new trench design was recommended. The bottom of the trench, covered with 6 in. of gravel, sloped to an asphalt-lined sump at one end in which a 6-in. perforated casing was installed. Any liquid entering the trench flows primarily through the gravel underdrain to the collecting sump, whence samples can be withdrawn and analyzed. In the two trenches that were completed waste containers were placed upright in one and were simply dumped in the other. Beta, gamma, and alpha activities were detected in water samples taken from the sumps. Monitoring data indicate that damage to the containers does not cause an increase in the activity leached. The additional cost of the sump, well, gravel underdrain, and asphalt cover was \$0.02 per ft^3 of trench space. The cost of protecting the drum by careful placement in the trench was \$0.07 per ft^3 of trench space. (auth)

12642 (TID-11725) RADIOACTIVE WASTE DISPOSAL SYSTEM TEST TANK THERMAL AGITATION. CORE I, SEED 1. Test Results RNI-5. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 17, 1960. 9p. (DLCS-2550101; DLCS-2550102)

An evaluation was made of the efficiency of the thermal agitation produced by immersion heaters in the Radioactive Waste Disposal System Test Tanks. Neither the first nor the second performance of this test proved that the thermal agitator was capable of mixing the test-tank water. The first performance showed a slight decrease in sulfate concentration, whereas the second performance indicated that the concentration increased during the test period, and in both tests the sulfate content of the samples was more than double the desired 200 ppm. (auth)

12643 (JPRS-4103) OCEAN DEPTHS AND THE PROBLEM OF BURYING RADIOACTIVE WASTES IN THEM. V. G. Bogorov and B. A. Tareyev. Translated from Izvest. Akad. Nauk. S.S.S.R., Ser. Geofiz., No. 4, 3-10(1960).

A discussion of waste disposal in ocean depths and, especially, in deep sea trenches is presented. A listing of the 23 known trenches with their position and depth is included. Factors affecting material dispersion are considered, and it is concluded that this disposal technique should not be undertaken until further research proves that it is feasible. (J.R.D.)

12644 (NP-tr-557) EFFLUENT TREATMENT AT THE KARLSRUHE ATOMIC RESEARCH CENTRE. S. Krawczynski. Translated by R. Todd (U.K.A.E.A. Atomic Energy Research Establishment) from Gas- u. Wasserfach, 101: 909-14; 969-72(1960). 34p. (Includes original, 7p.)

The effluents are classified as: rain water; domestic waste (sewage); uncontaminated chemical effluents; possibly contaminated wastes; contaminated chemical effluents; reactor cleaning water; and liquid radioactive concentrates. The rain water is untreated and used for irrigation of ploughed fields and pastures. The domestic effluents are sent to the biological purification plants, treated, and conveyed to final delay tanks before dumping. The uncontaminated chemical effluents are chemically treated for neutralization and removal of poisons, then sent to the final delay tanks. The radioactive effluents are collected and decontaminated by chemical precipitation, ion exchange, and/or evaporation. The effluents are collected in the final delay tanks, which are emptied only when the specific activity and chemical composition have been determined. The final delay tanks ensure that no water can leave the center uncontrolled. The highly radioactive liquid concentrates are collected and converted to concrete by mixing with cement, thus resulting in a good fixation. The chemical precipitation, ion exchange, and evaporation methods used in the decontamination processes are described. (B.O.G.)

12645 EVALUATION AND STORAGE OF ACTIVE AND DOUBTFUL WASTES AT THE INTERIOR OF LABORATORIES. F. Dubois. Bull inform. sci. et tech. (Paris), No. 44, 38-44(Oct. 1960). (In French)

A hot laboratory has a disposal system for doubtful wastes and one for active wastes. The active and doubtful systems are described briefly by giving some indications on the selection of materials and linings. The active waste system is comprised of the reject points, the evacuation system, the storage, and the pumping system. Each part is described. (J.S.R.)

12646 THE DESIGN OF THE WASTE-TREATMENT PLANT OF THE CENTER OF NUCLEAR STUDIES OF FONTENAY-AUX-ROSES. G. Wormser. Bull. inform. sci. et tech. (Paris), No. 45, 23-8(Nov. 1960). (In French)

The treatment of wastes at the Center of Nuclear Studies of Fontenay-aux-Roses is discussed. The way by which the present design was reached is described. (auth)

12647 REMOVAL AND DISPOSAL OF SOLID RADIOACTIVE WASTE. A. S. Belitskiĭ, V. A. Knizhnikov, and V. Z. Agranat. Med. Radiol., 5: No. 11, 62-6(Nov. 1960). (In Russian)

The characteristics and design of containers and transport facilities for radioactive waste are discussed. Data on the safe disposal of radioactive waste are given. (auth)